Volume III Number 1 1960

CURATOR

A Quarterly Publication of The American Museum of Natural History

CURATOR

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CURATOR is published quarterly by The American Museum of Natural History, Central Park West at 79th Street, New York 24, New York. It is a journal of opinion, and the views expressed in its articles are not necessarily those of the Museum.

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The Preparation of Biological Museum Specimens by Freeze-Drying

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There is probably no more convincing demonstration of the problems facing the taxidermist than that experienced by the amateur on his first attempt. In this regard the author speaks from experience. Although the resulting solution to this challenge may appear to the professional taxidermist as downright cheating, the quality of the results and the applicability of the technique to hitherto unpreservable material may be some compensation.

Freeze-drying, dehydration from the frozen state, is a well-established procedure used primarily by the pharmaceutical industry for the preparation of soluble drug preparations and by medical research for the preparation of histological specimens. In the former application the primary value of this technique is in the high solubility it imparts to the dried product. In histology, however, freeze-drying permits the preparation of a dehydrated tissue specimen which has not been subjected to the fixatives that can seriously alter the integrity of the chemical components of the cell. The transition from the minute specimen of rabbit

(EDITOR'S NOTE: The present article by Dr. H. T. Meryman describes the introduction of a completely new process for the preservation of zoological and botanical specimens for scientific study, as well as for exhibition. The preparation of specimens by freeze-drying as developed by Dr. Meryman may well mean a revolution in museum techniques that may have a profound effect on methods as practiced in natural history museums. Dr. Meryman is planning an extensive research project in which the freeze-dry method of preservation of biological specimens will be explored in all its practical aspects. The progress of this research will be reported from time to time in CURATOR.)

kidney freeze-dried for microscopic study to the whole rabbit freeze-dried for museum display involves only minor modification in technique and equipment. The following discussion of the theory and mechanism of freezing and freeze-drying, although not essential to the technician, should aid in the understanding of the procedure and in any undertaking of a further development of the process on more than an empirical basis.

THEORY AND MECHANISM OF FREEZING AND FREEZE-DRYING

Mechanism of Freezing (*Meryman,* 1956): The act of freezing involves the removal of water from the tissue solution and its concentration into ice crystals which can be regarded as inert foreign bodies. Freezing is dehydration in which the water is isolated locally in the tissue rather than being completely removed. Between ninety and ninety-five per cent of the water in tissue is freezable, so that dehydration by freezing is not complete. The water that remains, however, is chemically involved with the tissue components, and tissue with five per cent residual water appears dried to sight and touch.

The rate of freezing determines the size of the ice crystals that are formed. At very slow rates, such as would be obtained in a conventional deep freeze, the ice crystals will grow to many times the size of the individual cell. These crystals appear, however, to be exclusively extracellular, and as they grow, removing water from both intracellular and extracellular locations, the cells collapse passively into the interstices between the ice crystals (Meryman, 1957). This does not appear to produce any mechanical damage to a soft-tissue cell, as it will re-imbibe water upon thawing and appear unchanged on subsequent histological examination. In fact, if the duration of freezing has not been excessive, many cells will survive freezing, thus demonstrating that ice-crystal formation *per se* is not necessarily lethal. The present hypothesis for the source of injury to frozen cells is based on the effects of the dehydration rather than the physical presence of the crystals. With increasing removal of water to form ice there is a corresponding increase in the concentration of cell solutes. The best evidence at present indicates that a denaturation process resulting from the high salt concentration is the primary cause of cell death. However, despite the lethal effects of this salt concentration, histological integrity remains excellent following freezing and thawing provided there is no opportunity for autolysis following rehydration.

As the rate of freezing is increased by the immersion of specimens into cold liquid media, the size of the ice crystals becomes smaller and their number correspondingly greater. Ultimately, with extremely high rates of freezing, the tendency for extracellular crystal formation is overwhelmed and crystals begin to appear within the cells. At our present stage of experience this appears to be a uniformly lethal development.

Tissues subjected to very rapid freezing do not survive, with the single exception of red-blood cells, which are unique both because of their small size and their lack of internal structure (Meryman and Kafig, 1955). The histological integrity of tissues frozen with intracellular ice-crystal formation also suffers. Nuclei appear pyknotic, and there is a suggestion of disruption to cytoplasmic components. Contrary to general opinion, then, it is slow freezing rather than rapid freezing that gives the best recovery of both histological detail and viability.

We should note in passing that excellent survival of living cells can be obtained with slow freezing if glycerin is added preliminary to freezing (Harris, 1954). Glycerin binds water in the ratio of three moles to one, preventing it from freezing. Thus the addition of a few per cent of glycerin can reduce the amount of freezable water from ninety to ninety-five per cent down to about seventy per cent, at which level the concentration of electrolytes is not sufficient to cause rapid injury. In the presence of ten to fifteen per cent glycerin almost all mammalian tissues have been successfully frozen to very low temperatures and thawed with the maintenance of viability.

Freeze-Drying: If cellular material is allowed to dry at room temperature, a severe shrinkage results, the material becomes relatively insoluble, radical changes in the chemical makeup take place, and the cells are apparently irreversibly injured. The technique of freeze-drying was developed with the hope of preventing these alterations (Harris, 1954). This technique basically consists of freezing the material, maintaining the temperature low enough to prevent either chemical changes or further ice-crystal development, and then removing the water from the ice crystals by the transfer of water from the solid directly to the vapor phase. This is most commonly achieved by exposing the material to a relatively high vacuum while it is maintained at low temperature. The choice of temperature is determined by the purpose of the freeze-drying. For many pharmaceutical preparations solubility is the principal goal. A solution or suspension that is frozen contains many ice crystals scattered through the solid. When this ice is removed by sublimation, holes remain, and the dried material has a light spongy structure which goes into solution readily. For such a purpose drying is carried out at as high a temperature as possible short of actual thawing. Where histological detail is desired, the drying is usually done at –30° C. or lower. At higher temperatures ice crystals continue to grow in size through a transfer of water from the smaller crystals to the larger, resulting in undesirable artifacts visible under the light microscope. The time required to dry is an exponential function of both the size of the specimen and temperature. A specimen a few millimeters in diameter can be dried in a few minutes at a temperature close to 0° C. but will take several hours at –30° C.

The freeze-drying process can be subdivided into three portions. The first is the conversion of ice to vapor. Such a conversion occurs at a rate dependent upon the temperature of the ice crystal. The lower the temperature, the fewer water molecules will leave the crystal per unit area in unit time. However, water molecules may also return to the crystal, so that, unless they are removed from its vicinity, a steady state will result, with no net change in crystal size.

The second step in drying, then, is the removal of the water vapor from the vicinity of the ice crystal out through the dried shell of the specimen to the specimen surface. Such a transfer occurs by simple gaseous diffusion. The major resistance to this diffusion is the obstacle of the dried shell, and, as molecules wander about within this structure, they diffuse to the specimen surface only if a lower water-vapor pressure exists at the surface. Thus the principal aim of a freeze-drying device is to maintain as low a water-vapor pressure as possible at the specimen surface, so that the maximum vapor-pressure gradient can exist between the surface and the ice crystal within the material.

Removing the water from the surface of the specimen is the third phase of the freeze-drying procedure. Until quite recently this has been done exclusively by exposing the specimen to a relatively high vacuum. Decreasing the pressure of a gas increases the mean free path which is the average distance that a molecule can travel before striking another. The mean free path at one micron (10^{-3} mm.) of mercury is roughly 6.5 centimeters. This effects a considerable increase in diffusion rate and improves the efficiency with which water-vapor molecules reaching the specimen surface will find their way out of the system. Also, of course, if a pumping system will maintain a one-micron pressure, the partial pressure of water vapor obviously cannot rise above this. When a vacuum system is used, water vapor is generally trapped by a chemical desiccant or by a low-temperature condenser. Recently a method has been described by which drying can be carried out at atmospheric pressure by the passage of very dry air over the specimen to wash away the water vapor as it reaches the specimen surface (Meryman, 1959).

It should be noted that the conversion of water from ice to vapor requires energy, the latent heat of sublimation. As sublimation from the ice crystal progresses, this heat must be supplied from without, or the specimen temperature will fall and the rate of sublimation will decrease. Thus drying must be supported by an input of heat. This heat must pass by conduction through the dried shell of material which is a rather effective insulator. It appears that, for larger specimens, much of the

Fig. 1. The posing of a laboratory rat by freezing the joints with liquid nitrogen.

Fig. 1

prolonged drying cycle is the result of inefficient heat transfer to the specimen interior. The use of microwave heating which generates heat within the specimen through electrical oscillations appears to offer a solution for this problem and may be of considerable value for the particular application with which this paper is concerned (Copson, 1958).

FREEZE-DRYING OF INTACT MUSEUM SPECIMENS

The primary technical aim of museum display preparation is the unaltered maintenance of external form and color. Not only can this limited requirement be effectively met by freeze-drying, but there are ancillary virtues which may be of considerable value. Preparations collected and dried in the field or over a period of time can be available for subsequent anatomical or histological study. Although a great deal of tissue distortion results from the relatively crude drying at high temperature, rehydration permits a surprisingly good resumption of histological detail. If the rehydrating solution incorporates a fixative that prevents immediate autolysis, good study material can be prepared. Specimens prepared by freeze-drying can be processed intact with no prior dissection or alteration of the specimen whatsoever. Specimens need simply be posed, frozen, and dried. In the following discussion of the technique, the various aspects of the procedure have been subdivided and discussed individually.

Posing: In the initial stages of experimentation with this technique, the problem of posing specimens was probably the most difficult. An animal in rigor could not be posed at all, and when it was flaccid the apparatus necessary to support it at all critical points simultaneously became fantastic in its complexity and ultimately too large to fit into the freezer. Happily a solution to this was devised by which it is possible to pose and freeze the average specimen within a few minutes.

The present technique consists of freezing individual joints one at a time and is remarkably simple to carry out. Liquid nitrogen is the freezing agent used. This is an odorless, non-toxic gas available in liquid form. It is delivered in insulated tanks at atmospheric pressure. Under these conditions it is at its boiling point of −197° C. When removed from its insulated container it evaporates rapidly, leaving no trace of wetness or oiliness such as would be produced by almost any other liquid coolant. Despite its extremely low temperature it is not hazardous to use. When accidentally splashed on the skin it boils so readily that the skin is hardly cooled.

In practice, the posing is carried out as follows. The animal is supported by hand in approximately the desired pose, and the general position of the legs in relation to the body is determined. The specimen can then be laid upon its side or back and a few ounces of liquid nitrogen poured on each hip or shoulder joint as they are held individually in the desired

position. The specimen is then supported erect, and the joint position is checked. If the latter appears to be correct, it should receive an additional dousing of nitrogen. Where slight modification is needed, the application of a hand to the joint will warm it sufficiently to allow it to be gently flexed. This same procedure is pursued throughout the entire specimen, each joint or appendage being fixed separately as needed, with subsequent correction possible after slight thawing. Working with the whole animal has several advantages. With the bony structure intact, it is clearly difficult to pose the animal in an impossible position or to lose the size relationships of various portions of the body. With an animal or bird that is standing on one or two legs or perched, it is obvious when proper balance has been achieved.

Freezing: The initial freezing carried out during the posing is quite superficial, and it is necessary to freeze the specimen thoroughly before drying. After being posed, it is placed in a conventional deep freeze, where it should remain for several hours. It is unsatisfactory to complete the freezing with liquid nitrogen. The extremely low temperature of this material freezes the surface of a specimen so rigidly that it is not sufficiently plastic to adjust to the expansion that occurs when the interior is frozen. A specimen completely frozen in liquid nitrogen will crack open in several places. Leaving the material in the freezer for an extended period of time is also undesirable and may result in a slow superficial drying, with shrinkage and discoloration familiarly known to the food industry as "freezer burn."

Drying: Drying is carried out in a chamber maintained at low temperature which can be exhausted to a low pressure with a vacuum pump and which contains a chemical desiccant for the purpose of removing moisture. Alternately, one can use a gas-ballasted vacuum pump with which the water vapor can be removed directly through the pump. If this latter system is used, a pump of fairly high capacity is necessary, particularly if a large drying chamber is used. A pump with a capacity of 500 liters per minute or greater is suitable for a chamber of several cubic feet in volume. Such a system should be able to maintain an absolute pressure of twenty-five microns or better. If a chemical desiccant is used, the type known as Molecular Sieve[1] is recommended. This material has a high capacity for water absorption and maintains a very low vapor pressure. It is possible to reactivate this material by baking it at high temperature so that it may be used repeatedly. Obviously the desiccant

[1]Linde Company, a division of Union Carbide Corporation, 30 East 42d Street, New York 17, New York.

Fig. 2. Autoclaves converted into vacuum chambers, located in a cold room.

Fig. 2

must be renewed frequently to prevent it from becoming saturated and losing its effectiveness as a drying agent.

For the preservation of animal tissues a temperature not higher than –10° C. is recommended. This is sufficiently low to prevent demonstrable external shrinkage. A temperature five degrees lower is necessary for plant tissues. It is, of course, desirable to use the highest possible temperature, as drying time is an exponential function of this factor. If the chamber contains only one specimen, a rough estimate of the completion of drying can be obtained by monitoring the pressure within the chamber with a vacuum gauge. However, this is not wholly trustworthy, and in any case there are usually several specimens in various stages of drying. One way to determine dryness is through periodic weighings of the specimen until a constant weight is achieved. The balance should be kept in a deep-freeze unit so that the specimens can be weighed without their being thawed and so that there will be no condensation of moisture. There is no contra-indication to breaking vacuum and opening the drying chamber periodically other than the introduction of moist room air which will further load the chemical desiccant. The table lists the drying times experimentally determined for a variety of specimens.

It is obvious that there is a general relationship between total body weight and length of drying time. Such a relationship is considerably affected, however, both by the permeability of the epidermis and by the water content of the specimen. For example, even large mushrooms such as the boleti will dry in from one to three days, whereas the tail of a mouse may take as much as one or two weeks longer than the mouse

Fig. 3

Approximate Drying Times for a Variety of Specimens

SPECIMEN	STARTING WEIGHT	FINAL WEIGHT	DRYING TIME
Red squirrel	110 grams	50 grams	4 weeks
Red squirrel	156 grams	48 grams	6 weeks
Gray squirrel	376 grams	132 grams	9 weeks
Flicker	116 grams	44 grams	4 weeks
Fowler's toad	25 grams	15 grams	9 days
Garter snake	5.5 grams	1.6 grams	8 days
Horned dace	31.7 grams	7.3 grams	7 days
Horned dace	11.9 grams	2.7 grams	4 days

itself. Spiders and small insects generally dry in twenty-four hours, as do most plant tissues. In general our practice is to leave specimens in the drying chamber about fifty per cent longer than we estimate the drying should take.

Preservation Following Drying: One would expect on almost any reasonable basis that specimens that have been desiccated as described above would be exceedingly hygroscopic, would absorb moisture from the air, and would eventually decay in a most unattractive manner. Surprisingly enough, this is not the case. Many specimens preserved by freeze-drying have so far survived more than six years without benefit of air conditioning or humidity control, exposed to room atmosphere in the area of the city of Washington—no mean test of their durability. There has been no appearance in any specimens of softening, odor, or other indication of decay. We were particularly curious regarding the absence of fat leakage and rancidity. In 1958 a five-year-old specimen of a white-throated sparrow was diced and extracted with chloroform. More than a gram of rich yellow fat was obtained which showed no evidence whatsoever of rancidity. This fat was exposed in a thin layer to atmosphere during the summer, and faint rancidity was first noticed after nearly three months. At no time during the subsequent year did it become seriously objectionable. The mechanism involved is not completely clear, but it is assumed that the relatively crude freeze-drying inactivated all enzyme systems and that soluble gases were removed during the exposure to vacuum.

There is no indication that these specimens are impervious to parasites. Specimens to be maintained in a museum environment where contamination is expected would need to be poisoned in some suitable fashion. The edibility of unpoisoned material was confirmed by an unauthorized

Fig. 3. Conventional deep-freeze containing drying chamber (center), desiccant chamber (left), with vacuum pump outside freezer at left. The fox awaits desiccation in the autoclave shown in Figure 2.

experiment in which a trespassing gray squirrel consumed four freeze-dried birds with obvious relish and subsequent satisfaction. Although such thievery is not a common museum hazard, it does suggest that specimens are no less tasty in the dried form.

Eyes: In a fresh specimen in which the eyes have not collapsed through leakage of the vitreous, the freeze-drying procedure will preserve the intact cornea as it was in life. However, all color and transparency are lost. The cornea remains as a thin structure over the hollow eye and is white and opaque. In animals naturally having a black eye, the cornea can be painted with enamel following drying. In most cases, however, it is advisable or necessary to introduce an artificial eye prior to freezing.

Color: Most colors appear to survive unchanged. Feather and fur colors are quite unaltered. We have had good retention of color in the Amphibia but some suggestion of fading in the reptiles. Excellent color in caterpillars has been the rule. There is excellent retention of color in the mushrooms but an unfortunate loss of texture in some of the hydrophanous species. There are undoubtedly types of color that owe their existence to some dynamic quality which will be destroyed with the cessation of the metabolic process. Actual experiment will be the only ultimate answer in this regard.

Some species, particularly aquatic animals, have a translucency of the skin which derives from the fact that body tissue is essentially a single aqueous phase. Removal of the water produces a two-phase system which is no longer transparent and has an opaque and often somewhat chalky appearance. Some preliminary experiments have been carried out in an attempt to restore the single phase with a low vapor-pressure liquid. The silicone oils tend to darken the tissues and have not proved satisfactory. Diethylene glycol monoethyl ether has proved to be excellent in restoring translucency both of skin and of superficial mucous layers which dry white. This material, however, evaporates at a slow rate and must be re-applied periodically. It seems obvious that even a slight amount of additional investigation should produce a suitable material or a sequence of materials that would prove satisfactory.

Range of Suitable Material: The range of material to which this technique can be applied remains relatively unexplored. As far as the preservation of shape is concerned, there is no reason to anticipate any limitation whatsoever. Unsuitable specimens will be so because of peculiar qualities relating to color or transparency.

Fragility is another problem created by freeze-drying. Larger animals

Fig. 4. Some examples of the preservation of birds, small mammals, and a toad by freeze-drying.

Fig. 4

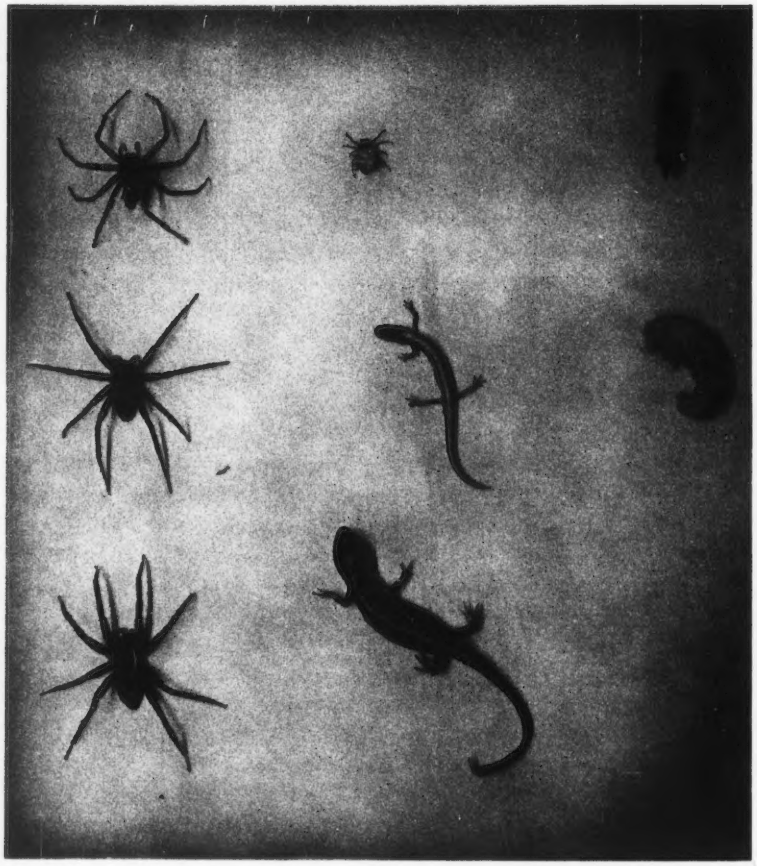

Fig. 5

are very sturdy and can be handled casually, but such fine structures as insect antennae and spider legs become extremely delicate. We have found that spiders may be best posed on the sticky side of adhesive tape. After freezing they can be teased loose and transferred to a permanent mounting board for subsequent drying. Any pinning that is necessary must be done prior to freezing because of the fragility and hardness of such specimens after they have dried.

Fig. 5. Spiders, insects, and salamanders prepared by freeze-drying.

Virtually no work has been done with plants, although early indications are that many will be suitable, particularly in view of the success of other methods of flower drying. The author's limitations in time, facilities, and knowledge have not permitted a thorough exploration of the range of applicability of freeze-drying for museum purposes, and it is hoped that others will be willing to carry out further exploration of this novel technique.

Conclusion: There appears to be an almost irresistible temptation for the professional taxidermist to take umbrage at this mechanization of his art. This may be justified if he chooses to define his art as the skinning, gutting, cleaning, and stuffing of an animal pelt. Then there is the less pedestrian view that the art is in the presentation of the dead animal as though it were living, in the knowledge of its pose and posture, its expression and attitude. A museum specimen, whether it be dried or stuffed, is no more a work of art than a bad photograph if it does not capture the subtle characteristics of the living animal. Taking this more sophisticated view of taxidermy, only benefit will result from dispensing with skinning and stuffing. One can now deal with material in which perfection is attainable. Dispensing with the tedious mechanics of preparation frees the artist for the pursuit of his proper goal. This goal is not the development of technique for its own end but the presentation of a dead animal that is alive.

Over and above the preparation of birds and mammals which, after all, can be prepared by taxidermy, the range of specimens that can be preserved, which previously were modeled or cast, similarly frees the artist from the repetitive execution of similar specimens to concentrate on some of the more challenging problems and to experiment with new techniques. Technical advances are not necessarily contrary to the interests of the arts, and there is no reason why the freeze-drying of museum specimens cannot be a case in point.

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Urban and Non-Urban Museums: A Subjective Comparison

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An earlier issue of CURATOR[1] carried an article by me entitled "The Impact of the Museum in the Hinterlands." When I wrote it I was the director of a hinterland museum, and the article was an expression of a resentment that museums in the great urban centers do so little for their yonland brethren. The resources of the great Eastern museums were so vast that, from a distance at least, their essential sense of localism seemed to be unreasonable.

Having since become the director of a museum in New York City, I have changed my point of view somewhat, or am changing it. I offer no apologies for the obvious schizophrenia in what follows. Nor, really, do I apologize for the generalizations. They may be the stuff of controversy but they are not quixotic.

Museums along the Atlantic seaboard, centering in New York City, are in general enormously impressive—there are so many of them, they are so obviously rich in treasure, and so many of them are admirably run. Their diversity and variety are amazing. In the face of grave fiscal problems, they are meeting an enormous increase in attendance since the end of World War II with intelligence and determination, if not with universal success.

But I have also discovered that an urban setting is not an automatic antidote to provincialism. Size does not always imply excellence; institutional tradition does not invariably predetermine the proper course for the future; and mutual admiration societies of professional museum people are sometimes substituted for cold and individual institutional introspection. In short, the urban museum not only is *not* immune from

[1]CURATOR, vol. 1, no. 3, summer, 1958, pp. 36–42.

the diseases of the hinterland museum, but in some ways it is more susceptible.

In the first place the large museums are caught up in an enormous increase in attendance and a consequently heavier demand for services. They cannot help this and, indeed, it is a wonderful thing. But as the visitors pour in, more and more of them every year, there sometimes develops a nearly malevolent impersonalism. Weary guards and weary curators and administrative personnel come to regard the "public" with near hostility.

A generation ago the great museums still found their *raison d'être* in the support of the knowledgeable and the passionate few. Today, in spite of some lingering inclination to hope that such is still the case, it is not. Regardless of the nature of the articles of incorporation or the proportion of private versus public money involved, the big and the middle-sized museums are clearly public institutions. What then of the surge of visitors, of vandalism, of jostling crowds, and of the increasing inclination to regard the "public" as the natural enemy? I suppose the only answer lies in being aware of the tendency, in patience, and in an intramural educational policy, especially for guards, that is aimed at creating as open and salubrious an atmosphere for the public as possible.

The hinterland museum will remain a friendlier place. It can afford a certain "community-center" aspect to its programs. It can hire far fewer guards per square foot, and, in truth, its whole educational program (for children and adults alike) can be conducted without frenetic agitation. Per capita, the hinterland museum may now be doing a better job in many respects than its urban counterpart. That is why the thinness (usually) of its collections is so disheartening.

There is another valid comparison. The Gilcrease Institute of American History and Art in Tulsa, Oklahoma, just as an example, can legitimately be called a hinterland museum. True, Tulsa is a city. But like other urban centers in the West and Southwest it is what Walter Prescott Webb calls an "oasis." The dominating factor in Oklahoma is not urbanism.

The difference in the attitude of the visitor to the Gilcrease Institute and, say, the Metropolitan Museum of Art is startling. The public approaches Gilcrease with a kind of reverence. One can see it in their faces and sense it in their lowered voices. Some even tiptoe. It is implicit, too, in the paucity of guards, in the invariable use of wastepaper receptacles, and in the general demeanor of the vast majority of visitors.

The typical visitor to the Metropolitan Museum shows no such reverence. Nor, in the average urban museum (art, historical, or scientific), does the public's approach to treasure seem to differ much from its approach to a county fair. People drop gum and paper on the floor. They

hurry from gallery to gallery almost on the run, and there is something almost shocking about the cursory glance they give a masterpiece. A great art museum takes on the essential aspects of a carnival.

Part of the explanation for such a difference undoubtedly lies in the very hugeness of the great Eastern museums. There are literally miles of things to see. One would quickly lose one's awe, and even curiosity, concerning gold if one wandered around Fort Knox for any length of time. The Eastern museums are so plethoric with riches that one's sense of rarity is easily dulled. And, again, it is simply a matter of numbers and human diversity. At least a few of the visitors to these institutions have literally wandered in off the street. They are not there with a purpose.

Is there a partial solution to this problem in our showing less and hence our emphasizing more the individuality and rarity of the things shown? The theory is attractive and is often expounded, but I doubt its validity. The Metropolitan Museum, for instance, does not "cram" its walls or corridors. It is simply an enormous museum with a great deal to show. Much of The American Museum of Natural History is beautifully arranged, and there is relatively little clutter. The Brooklyn Museum has plenty of alleviating interim space.

What truly seems a pity is that the wealth cannot be shared and that in those areas of the country where the hunger is greatest, the diet is leanest. It is certainly true that individual museums have standard loan policies. There are many traveling exhibits sponsored by the American Federation of Arts, the Smithsonian Institution, the I.B.M. Corporation, and others. But ordinarily such loans involve a jump from New York to San Francisco or Seattle, or to mid-country.

Especially since World War II, small but excellent museums have proliferated in all the vast country between the coasts. What they need is not so much "assembled" shows as fine individual examples. In art, for instance, one really fine El Greco would have enormous impact in the hinterland areas—in Boise, Spokane, Helena, Colorado Springs, Tulsa, Mandan, Las Vegas, Lincoln, and Santa Fe. Too often the traveling exhibits are second or third rate. However bucolic the setting, people either know or sense this. No loan at all is better than the condescension implicit in the loan of second- or third-rate material. One *fine* thing is better than a host of not so fine things.

The policy of most of the great urban museums in sending their staff members abroad so that they may gain perspective and balance is admirable; indeed it is imperative in many fields. But at least occasionally this policy should be augmented by their sending the same staff members across the face of America—not in a jet to San Francisco but across and up and down the country. While a density-map of museums would show

a very heavy concentration on the Atlantic seaboard, it does not follow that there is nothing to be learned outside this area. These urban museums are American museums serving Americans, and so mobile and peripatetic is the average American that it would be folly for any museum, however great, to lose touch with the country as a whole. A sure way to avoid provincialism is to keep in touch with the provinces.

Perhaps the salient advantage of museums in urban centers is that they can afford specialization. They are not forced to generalize unless they choose to. The result is that they dig deeper and are often fully satisfying to the most critical and demanding visitor. New York City, for instance, does not need a "general" museum covering American art, history, science, and industry. These, and many more facets of culture, are covered by separate and specialized institutions. The result is usually thoroughness and excellence. These museums are fountainheads of research and stimulation.

Yet the hinterland museum, the museum that is the only such institution within a radius of many hundreds of miles, is sometimes more ingenious precisely because it must generalize. It is forced into interpretation, into a preoccupation with coherence. As far as the "general public" is concerned, it may be a more sensible museum, and it may be more fun. Many an Eastern museum could learn a good deal about putting a sensible story together by a visit to the Nebraska Historical Society in the little city of Lincoln, for instance.

It is perhaps inevitable that the American Association of Museums should have an orientation towards (1) the East and (2) the large museums. It is regrettable, however, that this dual orientation is so pronounced. It would most assuredly be wrong to speak of the large Eastern museums as "jaded." Yet an enormous ferment and fertility of concept exist among the smaller hinterland institutions of which the Association seems largely unaware. What is greatly to be regretted is not so much that the Association at its annual meeting usually bores the hinterlander to distraction, but, rather, that the Association loses the stimulus which these excited yonlanders could impart to its proceedings.

New York City has a right to be proud of its museums. Not only are they plentiful, they are, in the main, excellent. This city alone has six science museums, seven historical museums, twelve historic houses, and nineteen art museums. It has, of course, in addition, literally dozens of private galleries, private collections, and great libraries. If it misses the mark of being what it presumes to be, "The Cultural Center of the World," it does not miss by far. And strung northward from Virginia to Maine, from Williamsburg to Old Sturbridge Village, are the country's, and the world's, most impressive restorations and re-creations—historic villages, towns, plantations, houses, and seaports.

This wealth of American heritage only percolates across the country at present via the memories of the tourist and his photographs, postcards, and pamphlets. But the once firm opinion I held, as a hinterlander, that the great Eastern museums were not living up to their responsibility because of their failure to disseminate, their failure to have a kind of national consciousness, is not really valid. One overriding consideration strongly mitigates against a further extension of services. Though there is great relativeness involved, the fiscal position of nearly all museums is basically serious. Indeed, many of the great museums are currently curtailing activities rather than expanding them, and quite properly so, because the long-range fiscal view for museums is a grim one. As Perry Rathbone of the Boston Museum of Fine Arts put it: "American museums are understaffed, their staffs underpaid . . . no amount of idealistic thought, imaginative planning, or specialized knowledge will quicken the future of our proud treasurers of art unless there is also that tangible asset essential to the job—hard cash." Mr. Rathbone is not merely singing the ordinary administrator's chronic blues, he is expressing the grave concern of museum people everywhere.

America's great museums have moved out of the era of the protection and support of the great patron into a kind of limbo. No one is picking up the tab fully enough. While clearly educational institutions, museums are rarely so considered when it comes to federal aid or even to foundation assistance. Inflation eats at their reserves. Labor, insurance, and all other costs increase far more swiftly than income, and there is no solution on the horizon.

In a thoughtful series of articles in *The New York Times* on the economic plight of United States museums, Aline B. Saarinen has done an admirable job of summing up the problems. She has suggested certain economies and new sources of revenue. Her principal suggestion, which is also the suggestion of Mr. Rathbone, is that corporate support should fill the gap.

In due course it may. It most assuredly has not done so as yet, and there may be more than a small element of wishful thinking in any serious reliance on such an ultimate contingency.

It is precisely the large and older museums in the country that are the hardest pressed in a relative sense. They have high standards to meet—standards that date back two generations or more. They have an enormous amount invested in their collections and in their traditions. It is harder for them to adjust, yet they are the hardest pressed by the inundation of visitors and by fiscal crises. Their problems are great because their needs are great.

Mr. Rathbone is right: "idealistic thought, imaginative planning or specialized knowledge" cannot be substituted for adequate financing.

But there is more actual latitude for ingenuity as a substitute for cash in the newer hinterland institutions than in the older urban museums. There are these also: greater proportionate civic and governmental support and pride. Such an assertion is no reflection on the civic-mindedness or generosity of urbanites. It is simply that the hinterland institutions are largely new and that they symbolize an intensely desired cultural maturity on the local level. To be sure, a strong element of chauvinism is apparent here, but support is support irrespective of the sociological roots from which it may stem.

America can, by one method or another, sustain its good museums, large and small, urban and non-urban. These are the only institutions that possess the objects of our heritage. A mature nation can no more afford to let these institutions wither than it can close its schools.

Labels: Writing, Design, and Preparation

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When labels are poorly written, designed, or mounted, exhibits as a whole will not carry the full impact expected of them. Indeed, they may be failures. The problems of visual communication in an exhibit demand that all three elements—design, technical preparation, and labels—be a unified whole, with each element brought to perfection and complementing the others. Some of the problems of design and technical preparation have been discussed in earlier issues of CURATOR. The lowly label, however, never seems to be the subject of discussions. *Yet most of the complaints from our visitors are directed towards the labels.* What further warning do we need to correct our most glaring defect?

WRITING THE LABEL

Writing for the British Museums Association, F. J. North (1957) states:

> It is because the museum has to bridge the gap between expert knowledge and public comprehension that label writing becomes so important and so difficult—important because it is the link between the curator and the public, and difficult because it means more than translating the results of modern research from the jargon in which it is often recorded into the language of the layman: it means arousing and stimulating an interest in the subjects with which museums can deal, for as the gap has grown wider and deeper the ordinary person has grown less and less inclined to take the first step towards bridging it.
>
> Recognizing that (much as we should like to think otherwise) the average visitor does not go to a museum for instruction, the curator's aim must be to create an awareness of the interest attaching to knowledge concerning the works of nature and of man through the ages, and to inculcate a desire to acquire such knowledge, for it is an axiom that the desire for knowledge begins in wonderment. Museums, no less than art galleries, have a potentiality to inspire as well as to instruct and it is one

of the purposes of the label to encourage visitors to seek information on matters in which their interest has been newly aroused by the exhibits.

The stimulation of interest of which Mr. North speaks must necessarily be created by the over-all design of the exhibit, and it must be conveyed on a first impression. Visual communication, i.e., specimens, models, graphs, charts, and so on, must convey the load, with the verbal communication, or label, adding support where it is necessary. The amount of support will naturally vary with each exhibit. However, the order of support in most instances will be the same.

First in the order and amount of support are the main title and the subheadings. They should be written and designed so that they are a part of the initial impact. The power of a question in stimulating interest is of value and is sometimes used to good advantage in titles and subheadings. More than anywhere else, here is where the clever choice of the fewest possible words is imperative. The viewer must be able to absorb these few words without realizing that he has been forced to read.

After titles and subheadings, the labeling generally breaks down into various categories such as main labels, secondary descriptive labels, and identification labels. The relative importance of these categories will vary with each exhibit and should be determined by the purpose and nature of the exhibit itself.

It is at this point that the perennial question arises, Should the label be written for a mass audience or for persons at a particular educational level? Obviously one label cannot be written in a way to stimulate all levels of education. Logically, the verbal communication must be broken down into a series of labels. If it be assumed that the interest of the most casual of visitors has been aroused by the three-dimensional parts of the exhibit, there should be a short statement in the form of a main label written in a style that is understandable to all of the reading public. This label must be simple and must at the same time so supplement the exhibit that our casual visitor has learned something, even if he does not progress (through lack of time or ability to comprehend) to the reading of the remaining labels. If the main label is cleverly written, there is greater possibility that the visitor will be encouraged to seek further information, by reading the secondary descriptive labels. The intelligent student or scholar should not be forgotten, which is another reason for keeping the main label short, so that he may quickly jump into the more comprehensive labels.

The secondary descriptive label is the main course, so to speak, of verbal communication. However, we must still respect the wide gap between curator and layman. It is not meant that this type of label should be highly technical. Even here the curator is not addressing his professional colleagues. At the end of this label it might be wise in some ex-

hibits to include a short bibliography to satisfy the quest for information of the visitor whose interests go beyond the means of the exhibit. After all, the exhibit should not be a three-dimensional textbook. Several curators have expressed the belief that this small addition might eliminate some of the numerous inquiries that they receive on the telephone daily. The small percentage of visitors whose interests have been aroused to this point should know where to find further information without bothering a curator.

Only a few words need be said about identification labels. The most important aspect is to maintain consistency in the order of the various elements, such as the popular name, the scientific name, the locality, the habitat, the geological horizon, and the biological status.

Because of the many problems that are connected with the writing of museum labels, it would seem to be an advantage to have a label editor as a member of the staff. There are only a few museums that have an exhibit program which would require the services of a label editor full time. In museums with smaller programs, this job could be added to the duties of the editor of scientific or of popular publications, or of a librarian. Even the smallest of museums, with limited programs, might take advantage of local writers for a small fee or even on a voluntary basis.

Through inquiries to other museums who make use of a professional editor of museum labels, some satisfying and interesting results were obtained. I should like to quote part of a letter received from John C. Ewers, Administrative Officer, Museum of History and Technology, Smithsonian Institution, in Washington:

> We have had the services of a full-time editor here for a little over a year now (November 18, 1958). I'm sure his services have led to the improvement of our labels. But first let me point out the division of responsibilities in the production of labels under the policy employed.
>
> All labels are first written by the curator who is the subject matter specialist in the field interpreted in the hall in which the labels will appear. Any changes the editor may suggest in the wording or content of the labels must receive the curator's approval. The curator is held responsible for the scientific or historical accuracy of all labels in the hall.
>
> The label editor tries to place himself in the role of the general visitor who has no specialized knowledge of the field interpreted by the labels he is editing. He is concerned that the labels be attractive in appearance, clear, interesting and understandable to such a person.
>
> He receives from the curator groups of labels for a case or for an entire hall (the latter is preferable). The labels for each case or exhibit unit are supplemented by a brief statement of the purpose of the exhibit and a listing of all other items which are to go into the case (specimens, graphs, models, etc.). These data provide the editor with the informa-

tion he needs in order to learn the ideas the curator wishes to present in each unit exhibit, and to evaluate the role labels should play in presenting the subject. Labels are *not* edited one at a time without reference to the exhibit context in which they will appear.

The label editor, as a matter of course, checks each label for accuracy in spelling (especially of proper names and place names), punctuation, capitalization, dates and figures. He appraises it from the point of view of style, use of words, and consistency with other labels in the exhibit unit and in the hall. If the label can be improved from any of these viewpoints, he does so. In some cases this may require only the substitution of a word; in others the whole label may need to be rewritten.

Two of the greatest advantages of the employment of a label editor, in my estimation, have been his ability to improve the wording of a label by substituting a simple word or phrase for a more technical one, and his ability to shorten the length of a label by rewriting. There have been noteworthy occurrences of the reduction of labels several paragraphs long to one, two or three sentences without omitting any essential ideas which the curator has wished to present.

The label editor is also vitally interested in the appearance of the label—that it should be attractive so as to invite the visitor to read it. A choice of type face that is most appropriate for the subject matter is important, as are the size and legibility of the type. The proper length of line, as well as the breaking of long blocks of copy into short paragraphs is also important in making the label readable. In making decisions regarding factors involved in the appearance of labels, the editor consults with exhibits design and production men.

As mentioned previously, any changes the label editor makes in the content of a label must be approved by the curator. If the curator questions the change, he confers with the editor; and if the curator still is unwilling to change, the change is not made.

The label editor serves important functions in scheduling the production of labels and in proofreading all silk-screen labels after they are returned from the printer.

I happened to be the curator in charge of planning the first hall upon which the present editor worked, the North American Indian Hall. Like most curators I think I can write labels. Yet, I know the editor was most helpful in many ways in improving the labels for this hall. Two heads are better than one, especially when that of the label writer is an ingenious one.

Let me cite three samples:

1. On a large wall map (18′ high) I wanted as short a label as possible to express the idea that the American Indians were a very ingenious people in employing the natural resources of their environment. I wrote a label to that effect. Then the label editor and I worked it over together until we were satisfied that it expressed the idea as simply and effectively as possible. When we finished, it was one sentence long. The label was produced through the stimulus of curator and editor working together.

2. For an introductory panel in this hall I wrote a general statement on the subject matter presented in the hall and turned it over to the editor. Employing the data given him, he provided a statement in free

verse which was much more attractive to the eye, and more readable than my prose statement. It has been very popular with our visitors. I have seen school groups standing before this exhibit reading the verse out loud in unison. I doubt if they would have read my original label in this way.

3. I prepared a label describing how pemmican was made. The editor recast it in the form of a recipe such as might be used by a housewife. This added immensely to the interest of the label for the modern reader.

These examples, I believe, are indicative of some of the kinds of improvements that can be made when one has a capable man on the staff who can devote full time to the problems of labeling. The curator often is so close to his subject that he tends to present his ideas in the accepted, stereotyped terminology of his profession. A fresh look at these ideas by a non-specialist writer often can result in suggestions for a more effective presentation of them to the general public.

DESIGNING THE LABEL

To parallel the categories discussed in writing the label—the main title is first in order and, because it carries the main support, should be a very obvious part of the exhibit design. Emphasis can be obtained by contrasting size, color, and dimension. Three-dimensional letters aid in giving impact to the main title. They also can be used in a smaller size for subheadings, if the exhibit is complicated by several subheadings. Titles may also be made more distinguishable by the use of all capital letters, a practice used in short statements, such as titles, but very rarely permitted in labels of any length.

Because our eyes have become accustomed to the configurations of the lower-case letter through the reading of books and newsprint, one should use lower-case letters in any copy long enough to require speed and accuracy without strain or fatigue. This requisite is one of many

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Fig. 1. An exception to advice against the use of three-dimensional letters for a long label. This is the main statement in the hall and is an enhancement of the large panel, which is an architectural element. The title was cut from wood one inch in thickness. The letters in the main statement were die-cut from cork.

Fig. 2. The unsightly crowding of many labels mounted on cards and attached to the wall has been eliminated in this exhibit by silk-screening the labels directly onto the wall. No third dimension in the labeling, therefore, competes with the specimens.

Fig. 3. A photographic enlargement, incorporating art work and labels, covers this entire panel. The specimens of eggs and the title, cut from cork, were mounted on the surface.

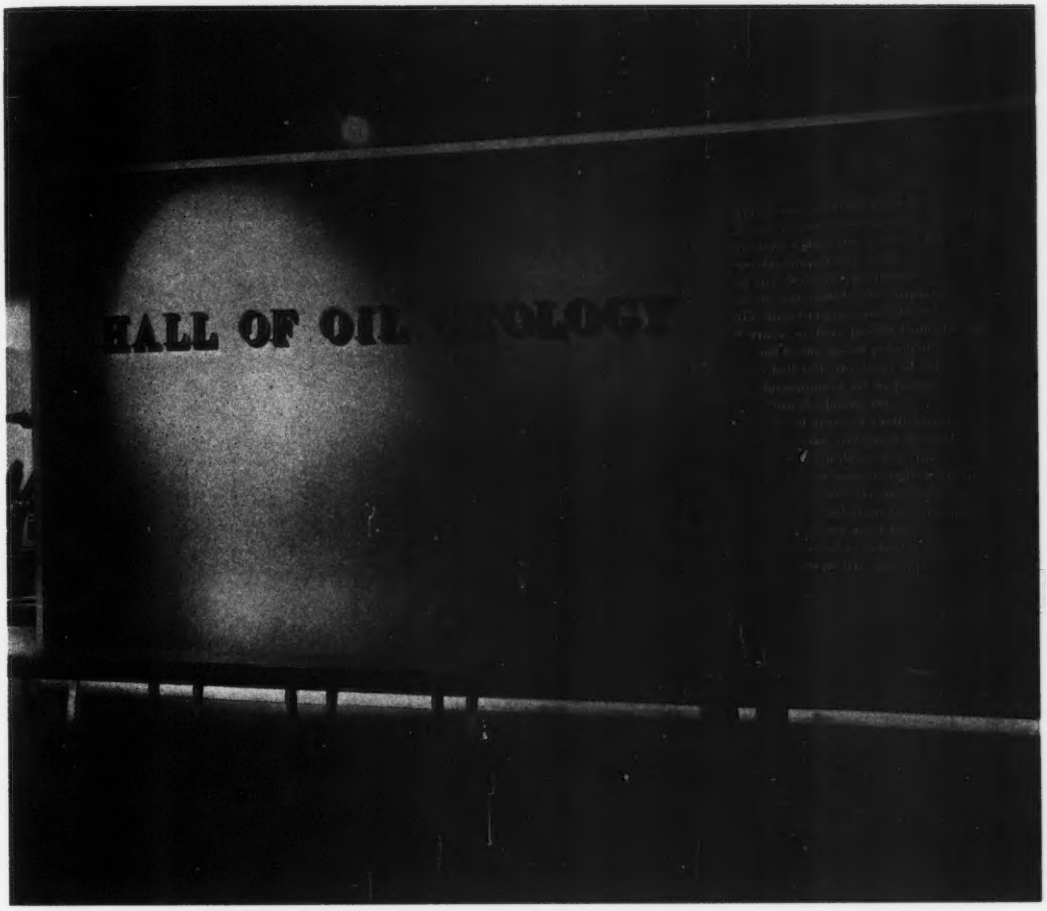

Fig. 1

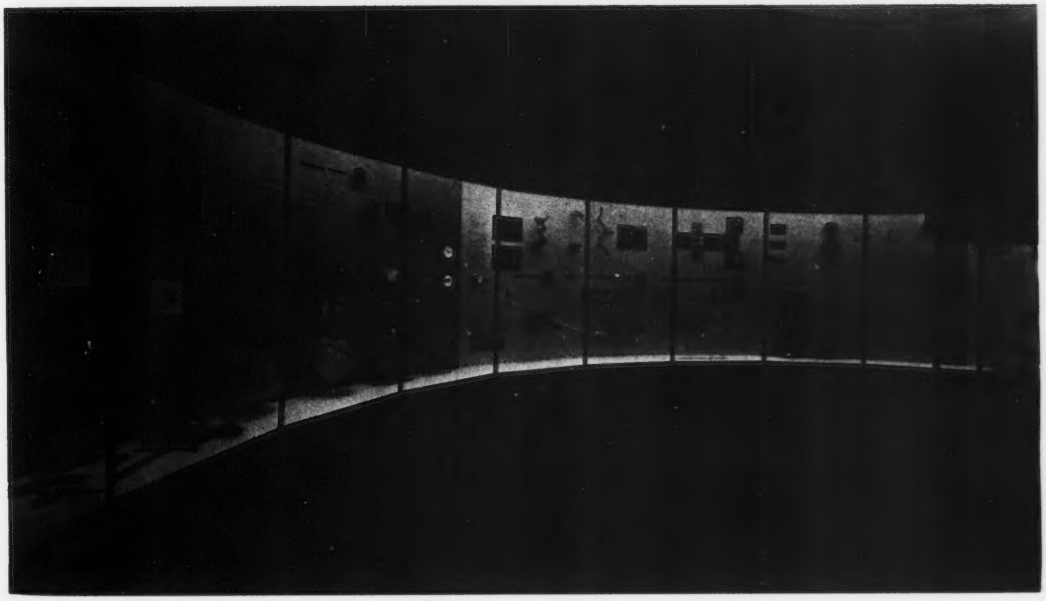

Fig. 2

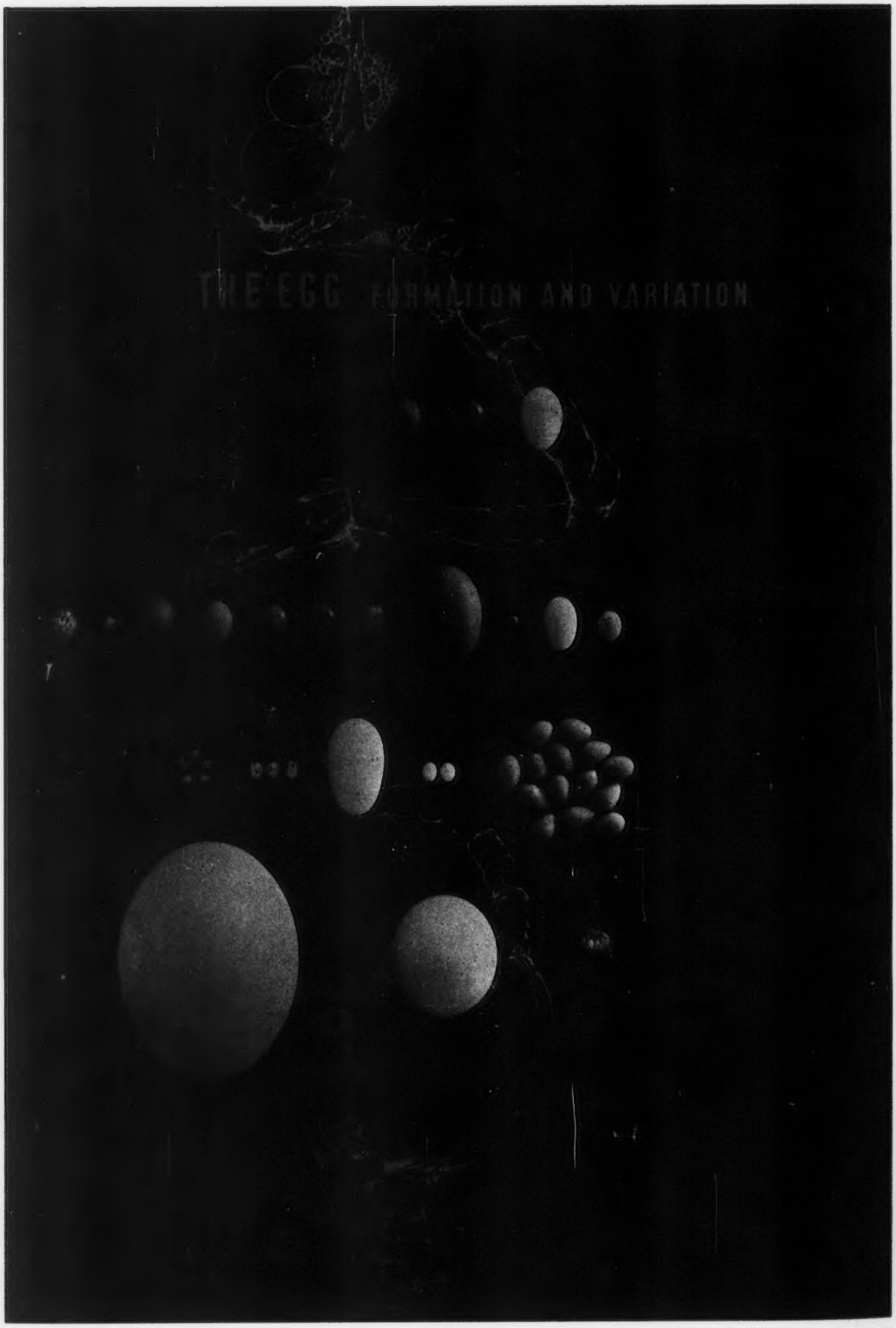

Fig. 3

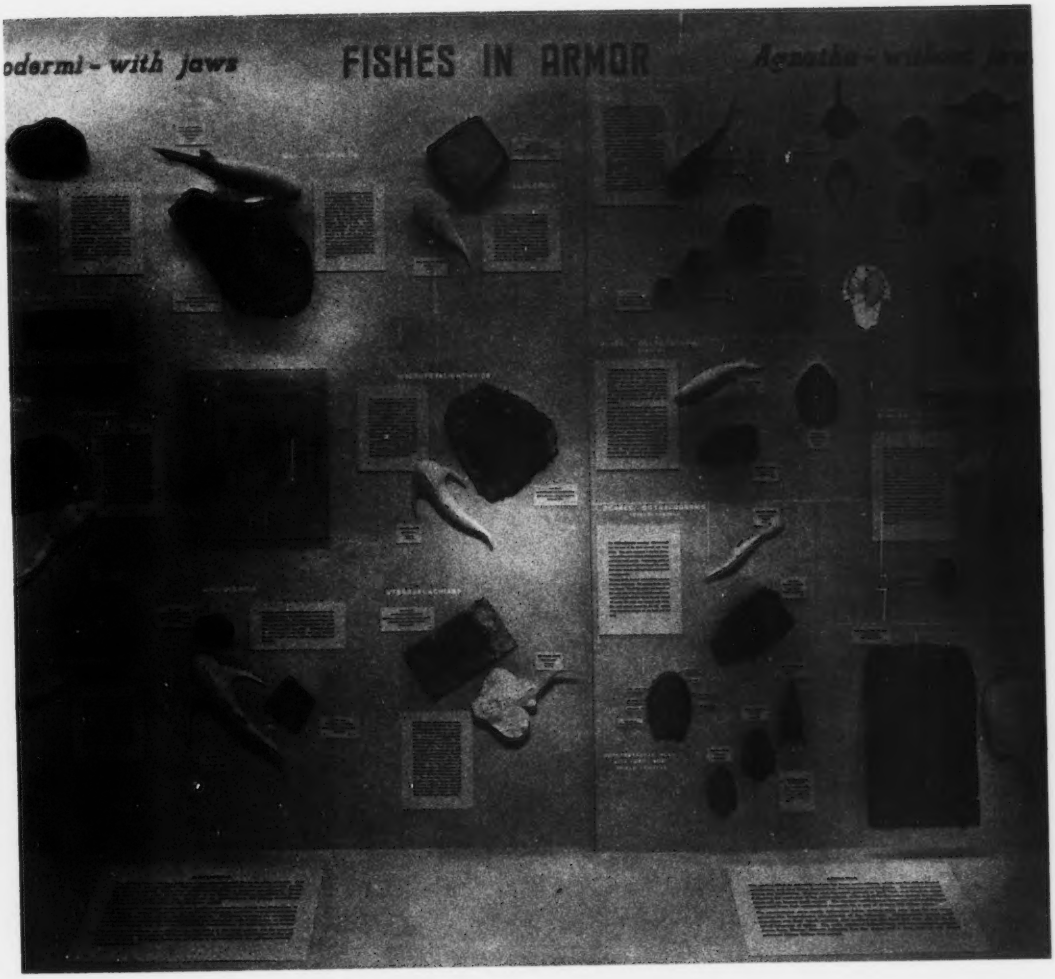

Fig. 4

Fig. 5

Fig. 6

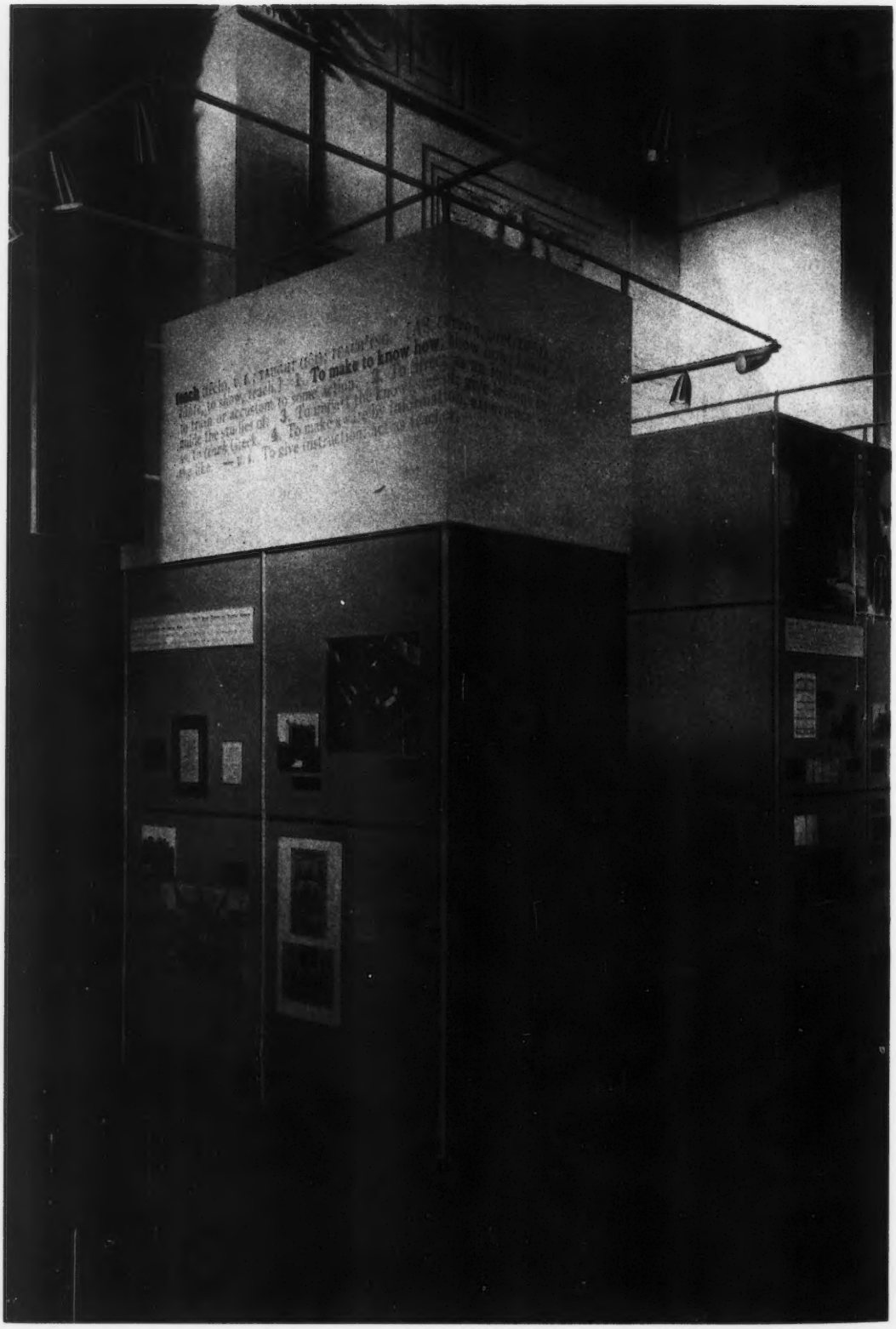

Fig. 7

for good *readability*. Others are design of the type face, type size, length of line, and leading between lines. A distinction should be made here between readability and visibility. *Visibility* refers only to the ability actually to see or distinguish letters or words as distinct from the background. High readability is not possible without high visibility. However, high visibility does not guarantee high readability.

Much scientific research has been conducted on problems relating to easy visibility and readability of printed material. At this point I wish to acknowledge the very helpful assistance of Dr. Arlene Tucker, formerly of the Department of Animal Behavior of The American Museum of Natural History, in compiling information on experimental studies connected with this subject. Luckiesh and Moss (1942) have devised a visibility meter for determining problems involved in *visibility*. Techniques used in determining *readability* include tests for speed in reading; records of eye movements during reading, taken either photographically or by the electrical recording of muscle potentials; records of the number of eye blinks that occur during reading; and introspective reports made by the reader concerning the ease of reading material. Although this research was conducted for reading distances of fourteen inches, we may project the results to suit the needs of reading material at distances occurring in various exhibits. The resulting figures, however, should determine a minimum, for the public has varying degrees of subnormal vision as well as different levels of education.

If there are secondary descriptive labels, the main label should be so designed that it catches the eye and is read first. This can be accomplished by several means. If space permits, the main label should have a position of its own and in no way be placed so that it appears, by proximity, to be a label for an individual specimen or model. The size of the type for it may be the same as that of the secondary label, if a

Fig. 4. A prime example of the cluttered appearance that results from the mounting of many labels on cards and attaching them to the wall. The inevitably three-dimensional aspect of the labels competes with the numerous specimens as individual elements in the exhibit.

Fig. 5. Photographic enlargement and cork letters of a title panel for a temporary exhibit.

Fig. 6. Labels that were made with an electric typewriter and enlarged photostatically.

Fig. 7. Some of these subtitles were enlarged photographically directly from definitions printed in a dictionary.

bolder type face is used. However, to insure distinction, the size should be larger as well. A change of color for the main label will accomplish the desired effect if, owing to space limitations, it must be placed close to other labels. The same general requirements for good readability and visibility apply to both the main label and the secondary labels. Because there is so much variation between the nature and purpose of each exhibit, the design and placement of the secondary descriptive labels will also vary considerably. The most important point is always to have good readability. As was pointed out above, the secondary labels also should be set in upper- and lower-case letters for ease in reading.

The selection of a type face is hazardous for the novice. Styles of type face come into and pass out of vogue as much, although with not the same rapidity, as women's dresses. Many standbys have, however, proved their legibility, a few of them being the Bodoni series, the Caslons, the Garamonds, and the more modern sans serif family. The last-named, the strength of which lies in its simplicity of form, has been in use long enough to be acceptable, but the eye still reads the older faces faster. A medium boldness in any type face has been found to be most readable. Italic letters should be used only for emphasis of a few words, not for the entire body of the text.

For secondary labels, I would suggest a twenty-four point type as a minimum under good lighting conditions and proper contrast. If space permits, a larger size should be used. This would apply to most wall cases that vary in depth from eighteen to thirty inches.

A comfortable length of line should contain between fifty and sixty characters (individual letters and spaces between words). Too short a line results in an uneven spacing between words from one line to another in order to avoid the division of words at the end of a line. Too long a line presents to the eye a difficulty in the picking up of the following line. If, at the end of a paragraph, the last word or two find themselves isolated on the last line, the copy should be edited, if possible, to eliminate this unfortunate "widow." It is no less readable, but typographically it spoils the appearance of uniform spacing between paragraphs.

Leading should be increased with an increase in the length of the line or with more boldness in the type face. Leading simply means additional space between lines, which is accomplished by the addition of thin metal strips (made of lead) between each line of type when it is set. If a label is set in twenty-four point Twentieth Century Light, only six points of leading would be needed, but if it is set in thirty point Twentieth Century Bold, the leading should be increased to eighteen points.

For museum labels, we are concerned with only three factors which determine good visibility: illumination, size, and contrast. Size is de-

scribed above as being one of the factors of good readability. Contrast between the letters and the background should be as strong as possible. Black letters on a white background offers the highest contrast. There is an equal amount of contrast between white letters on a black background, but the effect on the eye is more tiring. In most instances the background will be the color of the wall or panel in the exhibit case. However, intense colors, particularly the reds, should be avoided, if possible, for the background of labels. Improper illumination is a great detriment to good visibility. I was astounded at the low level of illumination which I found on a recent inspection of our own museum. I used an instrument called a Sight Meter, manufactured by Weston Electric Instrument Corporation. This instrument is similar to the light meter that is used in photography, except that it indicates the number of foot-candles of light that are being received. It is scaled thus: from zero to ten foot-candles, light inadequate for critical seeing; from ten to twenty, adequate for the reading of usual print; from twenty to fifty, adequate for the reading of fine print and newspapers, for sewing, and for good contrast; from fifty to seventy-five, necessary for severe visual work for long periods. The majority of exhibits that I checked showed less than ten foot-candles of light on the labels!

Within limits, a deficiency in one of the three factors affecting visibility may be compensated for by an adjustment of one or both of the other factors. Therefore, the seemingly low level of illumination in our exhibits is not so serious as it might first appear, because of adjustments that have been made in contrast and size, particularly in our more recent exhibits. A label may be quite readable in poor illumination if a large type size is used and if there is good contrast between letter and background. However, I would recommend a minimum of ten foot-candles where the lighting design of the hall permits.

Occasionally the design calls for a back-lit label of the negative type (white letters on a black background with the light from behind). In such cases, two factors should be kept in mind. The light coming through the label should be indirect. The intensity should be very low; otherwise great eye strain will develop. If possible, it is better to have a positive label (dark letters on a light background) silk-screened on opal glass which has been sprayed with, perhaps, a dull green paint. Properly lit from behind, this arrangement offers a label that has good visibility. Drawings also can be incorporated with the label quite successfully with this method.

To design good labels, one must have a knowledge of many techniques. The designing of a good exhibit with numerous labels, without giving the appearance of its being overcrowded with little rectangular cards, can be achieved by the silk-screening of the labels directly onto the back

wall. Having this technique available, however, should in no way excuse an excessive use of label material. For small museums with limited resources, there are still many ways in which good results can be obtained. The various techniques in the preparation of labels, from the simplest to the most complicated, are discussed in the next section. Regardless of what technique is used, good readability and good visibility should be of paramount importance in the design.

PREPARATION OF THE LABEL

The use of three-dimensional letters for titles and subtitles is quite practical because of the small number of letters that are required. The added dimension helps to give the title the emphasis that it usually needs. Many materials are available today, but all cannot be mentioned here. Catalogues showing the entire range of type faces and sizes can be obtained from each manufacturer. The names of manufacturers of similar products not mentioned here can be obtained through local art dealers and suppliers.

The least expensive three-dimensional letters are made of die-cut cardboard and can be used where permanence is not essential. When used inside glass cases, however, they should last as long as the life of the exhibit. A source for display letters of this type is: Hallcraft Products Company, 2930 North 11th Street, Philadelphia 33, Pennsylvania.

Die-cut cork letters of many styles and sizes, made in Paris by Graforel, are distributed in this country by the Grace Letter Company, 77 Fifth Avenue, New York 3, New York. These letters have a gummed backing; however, we prefer to cement them on with Rivet Glue (a casein adhesive) or some similar product. Additional security of attachment can be obtained by pinning through the letters into the background wall or panel. Drive in the pins halfway, cut the heads off, then drive in flush.

Molded plaster letters made by Mitten's Display Letters, Redlands, California, come in three types: Pin-Back Letters, for applying to soft backgrounds; Track Letters, for stand-up signs; and Sanded-Back Letters, for cementing to hard surfaces.

The same three types are available in a plastic ceramic composition letter manufactured by Hernard Manufacturing Company, Inc., 923 Old Nepperhan Avenue, Yonkers, New York. Polyplastic Forms, Inc., Gazza Boulevard, Farmingdale, Long Island, New York, make deep-drawn letters of acrylic sheet. These are used mainly for commercial signs and are consequently quite large. However, this last-mentioned firm has sizes in some styles that are small enough for use in museum exhibits.

The Lettering Centre, 61-62-63 Borough Road, London S.E.1, England, makes exceptionally fine letters in a variety of materials and an unlimited scope of type face designs. We have recently received samples

from this company, but at the present writing have not used their letters. Any inquiries to this company should be addressed to Mr. Ronald W. F. Bradford.

Titles and subtitles can also be hand lettered. However, I caution against hand lettering unless it is done by the most skilled professional, which is of course very expensive. Scarcely any part of the exhibit reveals the amateur more flagrantly or more surely results in poor readability than poor hand lettering.

The amateur, with a little practice and a good sense of letterspacing, can do fairly decent titles by pasting up commercially printed letters and then enlarging them by photostat to the desired size, using either the negative or the positive. These commercially printed letters consist of alphabets of most all type faces printed on clear, thin sheets of plastic which have an adherent on the back. A company offering many types and sizes in this medium is Artype, Inc., 549 West Randolph Street, Chicago, Illinois.

Filmotype Sales Company, 4 West 40th Street, New York 18, New York, is one of several firms that offer equipment for reproducing lettering on paper or film photographically. Although two-dimensional, letters made in this manner on clear film can be used for exposure on silk-screen film for titles.

In some instances, letters can be engraved on metal plates, and engraved or routed on lucite, or some other plastic such as varicolored laminations.

The Tablet and Ticket Company, with executive offices located at 1021 West Adams Street, Chicago, Illinois, is a large manufacturer of gummed paper letters, figures, and symbols.

Generally speaking, all labels other than titles or subtitles should be done with two-dimensional lettering, except, possibly, inscriptions, historical data, or similar material that is applied to a wall, either interior or exterior, and that is meant to be a permanent part of the building. Another exception is illustrated in Figure 1. Here the title was cut by hand from wood one inch in thickness. The general statement, or main label, for this hall was executed in three-dimensional cork letters, which in this instance add beauty and architectural detail to this very large panel.

The common typewriter should not be ruled out as a tool in acquiring inexpensive two-dimensional labels. Typewritten labels can be enlarged by means of a photostat; the enlargement is then mounted on a card or directly to the wall surface. Other machines suitable for labels are the jumbo typewriter and the electric typewriters. It is quite permissible to have a "ragged edge" on the right-hand side of a typewritten label. Indeed, quite obvious staggering of the right-hand line endings is pre-

ferable to an attempted alignment that is visibly not quite true.

Mechanical hand-lettering equipment such as Leroy is useful for inexpensive labels but requires much more labor than the typewriter.

If the budget will allow it, the most successful procedure for labels is setting them into type. A typesetter or printer can supply information on the several systems that are available locally. The printer should know in what form he must submit his final proofs: on acetate or tissue for silk-screen processing; on a kraft paper that has been sprayed with the same color as the background panel, which you supply to him; or reproduction proofs on a coated stock suitable to be pasted up with art work on designs to be photographically reproduced. The use of the photograph and the photostat makes possible the combination of art work, graphs, and label copy on one enlarged sheet of paper which can be mounted on a panel or case back in the same way that wallpaper is hung. Although the background is restricted to black and white, color areas can be added by being sprayed on, and specimens can then be mounted to the panel. This method can be used in lieu of silk screening to achieve the unbroken feeling of a panel on which art work is combined with a large number of labels (see Fig. 3).

An exhibit with many elements of design (specimens, art work, labels) can be made less complicated and therefore more pleasing to the eye by the elimination of the rectangles that are inevitable with labels that are printed or mounted on cards. As mentioned above, one method that almost achieves the desired result is the printing of the labels on a kraft paper that has been painted the same color as the background, but the edge of the paper still is visible and one is conscious of the edge of a rectangle, however muted. The use of photo-enlargements with all the label material combined on one sheet achieves the result, but it is limited in the use of color.

The ultimate results are achieved, with unlimited color possibilities, through the use of the silk screen. An example of an exhibit that was crowded with specimens, art work, and many labels is shown in Figure 2. This exhibit was "saved" from a design standpoint by our taking advantage of the silk-screen technique for all the labels, which have the feeling of being part of the background wall rather than obtruding as individual elements in the over-all design. This method is more expensive than the others because of the equipment, training, and labor that are required, but the results are more than worth the extra expense, not only so far as labels are concerned, but in the reproduction of art work in one or many colors on opaque or back-lit surfaces. Production details of the silk-screen process cannot be given in the present article, but will be described in a later issue of CURATOR.

If the small museum cannot afford the silk-screen process, the other

methods will serve well, with a little ingenuity used in the planning and designing stage and good methods of mounting. In general, mounting can be divided into two categories: wet and dry.

Dry mounting is a process that makes use of an electrically heated press in which are placed the mounting board, dry-mounting tissue, and the label or print to be mounted. The tissue has a heat-seal adhesive on both sides which, under heat and pressure, seals the "sandwich" together. This method is permanent, neat, and easy to use, and is not expensive after the initial cost of the press. A manufacturer of presses for this method is Seal, Inc., Shelton, Connecticut. Dry-mounting tissue can also be bought from Seal, Inc., or from a local camera supply house.

In wet mounting, one can find many glues, pastes, and cements that are excellent. Contact Cement, made by the United States Plywood Corporation, 55 West 44th Street, New York 36, New York, is quite permanent and sets upon contact. Rivet Glue, distributed by Behlen Brothers, Inc., 10 Christopher Street, New York 14, New York, is a milky-white adhesive which dries clear and sets in a few minutes. After dry mounting a label on a paper mounting board, we then cement it to a wall or panel (masonite or wood) with Rivet Glue.

Any firm that makes photo-enlargements or photostats usually is also prepared to mount them. Either the old wheat-paste method or the newer synthetics are used. All jobs of this type should be counter-mounted (the equivalent weight paper mounted to the back side of a panel to prevent the buckling of the panel). The edges can either be wrapped or be trimmed flush. Trimming flush is not so permanent, for the edges eventually curl away from the panel if the wet-mount method is used.

Another convenient mounting technique is achieved by the use of keyhole-like plates which can be obtained from local hardware stores. These plates can be mounted flush to the back of thick panels or on blocks that are cemented to the back of thin panels. The device is quite simple: the plate, which is screwed to the back of the panel, has a hole in it, the shape of which is an upside-down keyhole. This is slipped over a round-head screw that has been placed in the wall. Locking is achieved by moving the panel downward, once the screw head has been passed into the hole. It is advisable to put one plate in each of the four corners of a panel. These plates afford several advantages: large and very heavy panels can be hung on a wall rather than being cemented to it; panels can be hung away from the wall, which gives them a floating character; and panels for temporary exhibits can be easily removed from the wall whenever changes are to be made.

Labels in a natural history museum require close teamwork. If a worker fails in his task in any of the three categories that have been discussed above, the total effect of the exhibit will not only be weakened

but in some instances may be absolutely ruined. Emphasis should be placed on three elements: if possible, engage a professional label writer; keep good readability and good visibility uppermost in importance in the design; and make use of the best preparation techniques within the budget that has been allotted.

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The Lightbulb Angel: Towards a Definition of the Folk Museums at Cooperstown

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The word "museum" means, literally, seat of the Muses—any of nine sister goddesses, daughters of Zeus and Mnemosyne (one always has to specify which lady, where Zeus was concerned) who preside over different fields of inspiration. If I had to pick a Muse for The Farmers' Museum, The Village Crossroads, and Fenimore House—the related trio of indoor and outdoor folk museums of the New York State Historical Association at Cooperstown, New York—I think I would choose a patched and battered deity known around here as "The Lightbulb Angel."

Dr. Louis C. Jones, Director of the Historical Association, was driving through the rural countryside between Cooperstown and Albany about a year ago when he first saw The Lightbulb Angel, a forlorn but intriguingly shaped wooden weathervane silhouetted against the winter sky, perched on top of one of the lurching outbuildings of a roadside farm. Momentarily ignoring his appointment in Albany, he stopped and passed the time of day with the elderly farm wife whose late husband, it turned out, had cut the weathervane from an old pattern still stored in her attic. Originally the angel held a proper trumpet, straight as Gabriel's, but the end had been broken off and been replaced by a child's tin horn—the kind with a loop in the stem. This had been screwed on to what was left of the original stem, and a lightbulb had been jammed into the bell of the hybrid instrument, giving its angel the look of a fey but undeniably vigorous Bix Beiderbecke doing his muted solo perpetually downwind. For a modest consideration, the farm wife was willing to part with both weathervane and original pattern. The Angel now rests against the wall

Fig. 1

of Dr. Jones's office. Callers seldom notice it, for the opening door hides it as they walk in, and they must sit with their backs to it. But Dr. Jones can see it. Seated at his desk, he faces it whenever he looks up from his work. We have it, as the saying goes, under study.

The first problem, put bluntly, is to decide whether it is plain junk or a contemporary example of transitional folk art. Second, if it seems worth keeping, what are we to do with it? Put it and its pattern indoors, in the permanent Fenimore House folk art collection, or as part of a Farmers' Museum weathervane exhibit? Restore it to the design of the old pattern and stick it on top of one of the Village Crossroads buildings—perhaps the Lippitt Homestead barn or woodshed? Dr. Jones seems rather discouraged and embarrassed by the whole matter, as if he felt he had erred on this one, and that it is probably junk and not even significant junk. Maybe he is right. But even if it ends in the trash can, for me The Lightbulb Angel still symbolizes, more subtly and precisely than any other object I can think of, exactly what it is we are about, here in Cooperstown.

To begin with, we are concerned with social history.

So are many sister museums—Old Sturbridge Village, Colonial Williamsburg, Winterthur, Shelburne, Mystic Seaport, to name only a handful of the better known ones in the East. Yet I doubt whether any of them would be remotely interested in The Lightbulb Angel.

Fig. 1. Fenimore House, headquarters of the New York State Historical Association.

Fig. 2. A portion of the folk art collection on permanent display in the basement of Fenimore House.

Fig. 2

Fig. 3

Why should *we* be? It is not of "our" period: post-Revolution to pre-Civil War. It is a bastardized and contemporary object from a not very special pattern. Why was Dr. Jones concerned enough to buy it? To phrase the question objectively, what principles of selection operate at Cooperstown? What, aside from the obvious geographical and chronological characteristics that distinguish each institution, differentiates the Cooperstown museums from others in the "outdoor," social history category?

I think that now is the moment to admit that I have been in the museum field, and with the New York State Historical Association, for less than a

Fig. 3. "The Fenton Family." One of the few intact examples of a series of primitives, of the same family, painted at the same time. (Artist unknown; miniature water colors; circa 1835.)

Fig. 4. "Dancing Negro." (Wood carving, possibly for a sign; artist unknown.)

Fig. 4

Fig. 5

Fig. 5. Mermaid garden fountain. (Wood carving, sixteen by eighteen inches; artist unknown.)

Fig. 6. Ornamental eagle on shell base. (Wood carving; twenty-one and three-quarters inches long; painted; anonymous; second half of the nineteenth century.) From the Fenimore House folk art collection.

year and am therefore patently unqualified to give a professional answer to that question, But, not to overdo the modesty bit, possibly it does not call for an entirely professional answer; it may be that the interested amateur's, even the rank tourist's, answer is in some ways more to the point.

Certainly it was as a tourist in the summer of 1957, wandering through the big stone barn at Cooperstown with two small children in tow and two smaller ones locked in the car, that I first sensed a basic difference between The Farmers' Museum and the only other places vaguely like it that I had ever visited: Old Sturbridge Village and Mystic Seaport. My initial reaction was one of mild disappointment, followed by the realization that I had expected the Cooperstown museum to be something it had never tried to be—a full-blown recreation like the ones at Sturbridge and Mystic.

Neither of these places had entirely won me over on my first visit, but each had seemed singularly successful as a theatrical entity: one a beautifully recreated early nineteenth century New England village complete with common, mill race, wandering paths, and country lanes; the other a diminutive clipper-age seaport crowded with shops, dwellings, gulls, boats, and a three-masted whaler. Each offered a gigantic stage setting with authentic props, dozens of representative buildings and sufficient acreage, sealed off physically and acoustically from the modern mess outside its toll gate. One did not even have to enter the buildings

Fig. 6

to experience that willing suspension of disbelief which is one of the essential ingredients of good theater. In fact, I wish now that I had not looked inside the buildings at all on those first visits; surely the people who had inhabited such communities did not spend their afternoons charging in and out of their neighbors' houses. Some year (in Indian summer when the main tourist season is over but the weather still warm) I am going to devote a day to each museum just puttering about, dozing on the grass, perhaps ambling into one or two of the buildings, but mostly soaking in the atmosphere: immersing myself to the verge of feeling that I could have grown up there.

One might attempt that, and profitably, at Mystic and Sturbridge, but not at Cooperstown. In the first place one enters by way of an enormous stone dairy barn which has been converted into an indoor museum. Magnificent as this building is, it was built in the 1930's, and its purpose is not to enchant the visitor with a setting lifted intact from the past, but to house exhibits. Nor are the exhibits (showing tools of the farmer, his wife, and the craftsmen on which they depended) designed as spectacles; they consist of objects chosen and arranged to convey a feeling for how, and with what, the post-frontier folk made do.

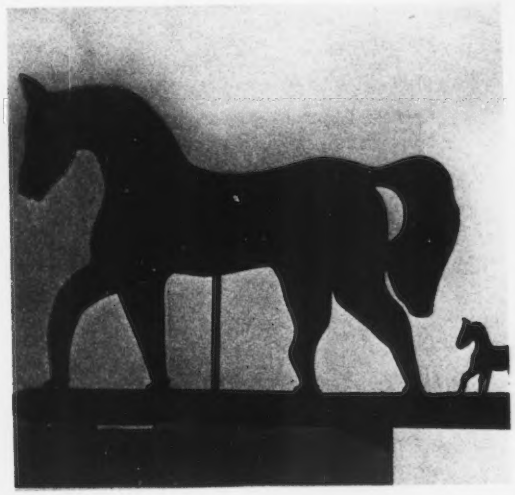
As one leaves the barn and heads for The Village Crossroads, the first place one passes is an administration building. This fronts on an oval of lawn which might have been cozied up to look like a village green, but wasn't. At one end of it lies the Cardiff Giant, in an open pit protected by a tent roof. The only other buildings on the circle are a country store and a schoolhouse.

Beyond this circle, set one next to the other with no real sense of constituting the main street of a rural village, are three shops (blacksmith's, printer's, druggist's) and two offices (doctor's and lawyer's). Across from these is a modest but stately tavern. And a little beyond them all, set in its own yard and attended by its pond and outbuildings, is a small farmstead.

Here, then, are nine authentically recreated main buildings of a somewhat arbitrary nature, lined up on a narrow half-dozen acres, flanked on two sides by a distinctly twentieth century golf course, and paralleling the heavily traveled lakeside road into town. As I have already hinted, I was not visually transported into a picturesque stage setting miraculously salvaged from the past.

On the other hand, I got something out of Cooperstown that was quite different from anything offered me by the other museums. At the time I

Fig. 7. Seven weather vanes from the large collection on view at Fenimore House.



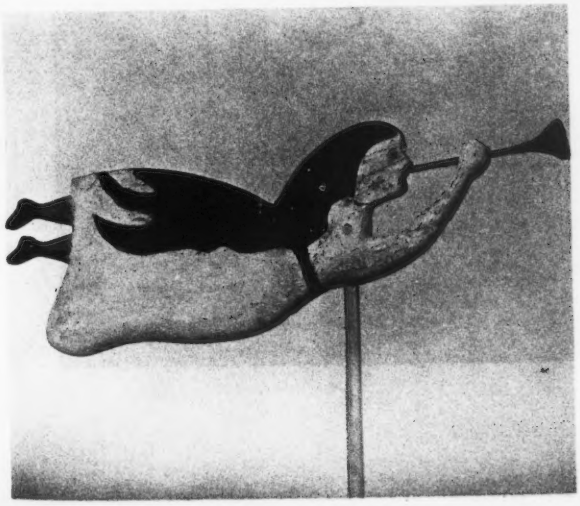


Fig. 7

Fig. 8

could not have explained what it was. Simply, I knew that I had fiddled and wondered more than at Sturbridge or Mystic. It never would have occurred to me to spend a day just wandering about outside the buildings, but I did want to stay inside them and handle everything. Partly, I was less in awe of what I was seeing. Nothing had a high polish or looked like a priceless example of its kind. For all their age and authenticity, the objects seemed only slightly removed from my world. They were comfortably *ordinary*, and the frontier farm folk evoked by them were real, not fictional. At Sturbridge, when I had tried to people the village in my imagination, I had thought (inaccurately) of "The Scarlet Letter"; at Mystic, I was Ishmael striding down the wharf to sign aboard the *Pequod*. But at Cooperstown, the people who came to mind were far less fanciful than characters out of novels. I thought of families still farming in the Sourland Mountains near Princeton, New Jersey, where I lived, and in the Alleghenies of Pennsylvania, where I used to go every summer as a child. Looking at a butter churn or a primitive implement for washing clothes, I conjured up the faces of those poor-white womenfolk whose photographs adorned so many documentary films during the depression. Running my hand over the wooden gears of an early corn-planter or the handle of a wrought-iron plow, I remembered stories I had heard about my own great-grandfather, who grew up on a farm near Chester, Pennsylvania, in the 1830's.

What I am trying to say is that I had become less romantically but more personally involved than at Mystic or Sturbridge, principally, I am convinced, because the museums at Cooperstown are suited to present a process, not a spectacle; a condition, not a scene.

Theirs is the story of how frontier forest was turned into farmland. They tell this story in terms of central upstate New York from 1785 to 1855, but historically speaking the "where" of it is unimportant compared to the "who," the "what," and the "how," for the frontier cycle was repeated, with little variation and in the space of a few generations, throughout the entire country west of New England. Connecticut seaports and Massachusetts inland villages between the Revolutionary and Civil Wars were not typical of the rest of the country during that period; they were indigenous to New England. They represented the final flowering of cultural seeds planted two hundred years earlier and cultivated assiduously in the same small rock garden. The scene itself, the spectacle, is decisive in their recreation. But scene is secondary to the Cooperstown recreation

Fig. 8. The Farmers' Museum, where tools of the post-frontier farmer, his wife, and the craftsmen on which they depended, are exhibited and demonstrated.

precisely because the frontier folkways being exhibited were not indigenous to a single region. After occupying a slender strip of land along the Atlantic seaboard for a hundred and fifty years, Americans crossed the Appalachians and in seventy-five years occupied an area some three thousand miles wide. The westward movement, which had reached Lake Otsego by the beginning of the period covered by The Farmers' Musuem, had pushed to the Pacific before the end of it. The communities that mushroomed westward from New England were far from picturesque, but at each pause along the way a dramatic and almost identical metamorphosis was taking place: a generally unsuccessful first-generation

Fig. 9. One of twelve consecutive displays (one for each month) in an exhibit entitled "The Farmer's Year." In all The Farmers' Museum exhibits, emphasis has been placed on simplification and clarification and on the evocation of the man behind the objects rather than on the mere display of a confusing clutter of old tools and implements.

Fig. 10. Husband and wife attending Seminars on American Culture try their hand at riving, or splitting, a shingle.

Fig. 11. A representative sight at The Farmers' Museum: visitors watching one step, the hetcheling of fibers, in the transformation of flax into linen thread.

Fig. 12. A family of four watches craft demonstration in the textiles hall at The Farmers' Museum.

Fig. 10

Fig. 11

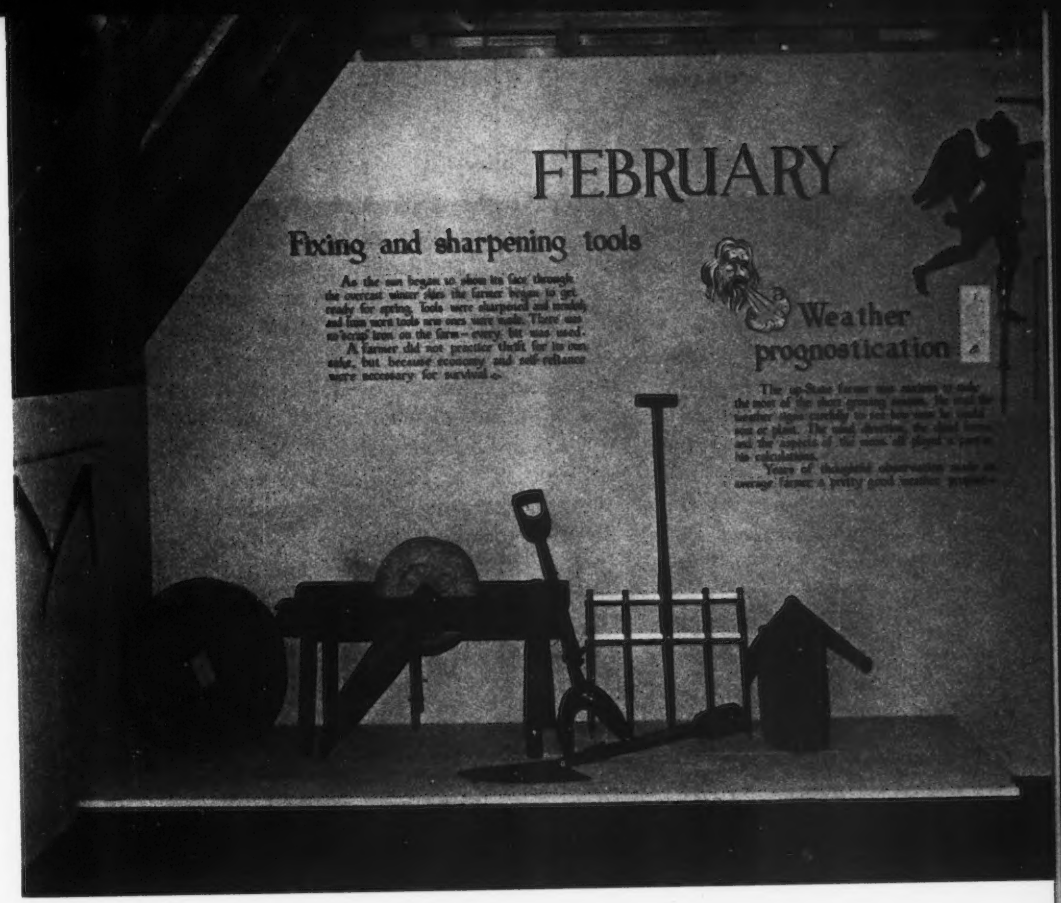

FEBRUARY
Fixing and sharpening tools
Weather prognostication

Fig. 9

Fig. 12

attempt to retain the relatively high cultural standards of the eastern settlements, followed by an unashamed second-generation drop to cruder standards in response to frontier conditions, and finally a gradual development of civilized communities which reflected some of the standards still in full force at villages such as Sturbridge and seaports like Mystic, but which added much that was new and antipathetic.

It was this fresh social synthesis, forged on the moving frontier, that placed its stamp once and for all on the national character. If my associations at the The Farmers' Museum were more personal than at Old Sturbridge Village or Mystic Seaport, it was because, while there was less there to enchant, there was more to recognize, more that was typical, more that was, and (as evidenced by such degenerated vestiges as The Lightbulb Angel) remains, central to the American experience.

Before enlarging on that admittedly subjective observation, I want to make it clear that I have used Old Sturbridge Village and Mystic Seaport as points of comparison because they succeed, and brilliantly, where The Farmers' Museum at Cooperstown could never hope and should never try to compete. Their definitive achievements in their particular areas of social history are exactly what make them such ideal counterweights for contrasting achievements in other areas. The time has long passed, if it ever existed, when museums feel that they must vie with one another, to speak of being better, rather than different. The crowds (relatively leisured, moneyed tourists) are growing every year for all of us. Every year more and more people become intrigued with the variety and complexity of our country's heritage. I suspect that the danger, in the outdoor museum field at any rate, is not that we shall not be popular but that we shall not know how to handle popularity, that we shall not be clear and confident enough about exactly what each of us is—of what, about each of us, has unique value—to sustain popularity without sacrificing integrity.

Whether or not it was ever stated in so many words, the unique opportunity of the New York State Historical Association to emphasize a central American experience must have been recognized from the start, for it seems to have shaped every aspect of the development of its museum. To begin with, it has made it into a teaching museum. Because so much of the post-frontier cycle is a story that must be told as well as shown, the Cooperstown complex has become, in effect, an indoor-outdoor class-

Fig. 13. The Village Crossroads, showing the printing office (1829), doctor's office (1829), druggist's shop (1832), and lawyer's office. All Crossroads buildings came from within a hundred-mile radius of Cooperstown, and were built within two generations of the settlement of the village.

Fig. 13

Fig. 14

Fig. 16

room for living history, rather than a stage setting.

This is apparent from the very way in which the physical plant has been organized. It consists of not one but three related museums, each supplementing the other two. The lawns and rooms of Fenimore House, which contains an excellent research library, some fine genre paintings, and an increasingly important folk art collection, serve as a kind of informal lecture area. Across the road sits The Farmers' Museum, which is an immense workshop, exhibiting, demonstrating, and inviting the visitor to handle the tools and vehicles used by the plain sort of men and women whose faces stare out from so many of the primitive paintings at Fenimore House. The adjacent Village Crossroads may be indifferent theater, but it is excellent for field study. It allows the visitor to browse through the buildings once frequented by the rural folk whose portraits he has seen and whose work tools he has felt.

In a sense, the Lippitt Homestead is the real heart of The Village Crossroads and provides the pulse for all three museums. For in just such modest dwellings lived the farm families who followed the earliest frontiersmen, built the little one-room schoolhouses, patronized the country stores, carved the weathervanes, sat for the itinerant painters, thronged to see hoaxes and marvels such as the Cardiff Giant, had their animals shod at the smithy, and took their ailments to the druggist or doctor's office, their complaints to the local lawyer, and their news of weddings, funerals, and strayed cattle to the printer.

Fig. 15

Each portion of the story lends life and depth to the whole. Without the Lippitt Homestead, the rest of the Crossroads would tend to be a dead collection of old buildings. Without the Village, the big stone barn might become merely a museum of primitive technology. Without either The Village Crossroads or The Farmers' Museum, Fenimore House would have a lot of anonymous objects to show but little to say about the kind of people who produced them. And without the folk art collections of Fenimore House the lives of those people whose work tools and buildings

Fig. 14. The 1810 Village Crossroads one-room schoolhouse "in session."

Fig. 15. An ex-blacksmith continues his trade at the 1827 smithy on Village Corners.

Fig. 16. Men set up printing presses and started newspapers soon after settlements in the Cooperstown area were organized. This 1829 shop, from nearby Middlefield, still turns out a newspaper and broadsides.

Fig. 17. Earlier than many visitors realize, growing rural communities attracted a druggist who sold herbal medicines, perfumes, paints, and other items. This Village Crossroads shop was built ten miles west of Cooperstown in 1832.

Fig. 17

Fig. 18

Fig. 19

are exhibited across the road might seem distorted and drab indeed.

The three museums have a vital connection, but they still add up to a teaching complex, not a spectacle. You do not walk directly into the past when you hand over your ticket at The Farmers' Museum; you walk among the implements with which plain people hewed a great nation out of the forest. The Village Crossroads is a representative and authentic sampling from one of the first transplantations westward out of New England, but not a replica of an early nineteenth century, post-frontier community.

To begin with, there is only one dwelling; only one, yet for the Association's purpose it bids fair to be enough. That purpose is to promote an understanding of the conditions in which the nation was born and bred, to do so on various levels, and to do it, wherever possible, through personal identification.

On the tourist level, this is done through exactly the kind of hold which the place took on me when I first went through it. It is difficult to analyze that hold. As I have already said, the very unspectacular nature of the objects has something to do with it—their familiar ordinariness. One does not feel awed by them, or like an outsider privileged to gaze upon priceless props from a past his forebears never knew. Nor are the exhibits cluttered and frustrating. They are designed to evoke the people who used the tools and implements, not merely display a meaningless collection of objects.

Wherever possible, the objects are shown in actual use: not only the many tools used by the farm wife to transform raw flax into linen cloth, but the carpenter's tools and the printer's, the blacksmith's, and the broom maker's. At Lippitt Farm, where flax and broom corn are grown, there are chickens, ducks, pigs, a few sheep, a team of oxen, the family cow—just what an average homesteader would have owned. Most of these animals have the run of the grounds. A calf may get in the corn patch, or sheep graze in the farmhouse yard, but nobody chases them out; they seem to belong there. They show up at the barn, though, at feeding or milking time. Season in, season out, the daily chores are done. The sheep's wool is used for yarn, and the cow's buttermilk is fed to the pigs. Her butter, along with chicken eggs, is used for the cakes that are baked in the beehive oven of the farmhouse kitchen and given to visitors if they happen by at the right time.

Fig. 18. Built in 1800, the Bump Tavern is a typical turnpike tavern, complete with taproom, ladies' parlor, gentlemen's reading room, ballroom, and bedrooms.

Fig. 19. The taproom of the Bump Tavern.

Fig. 20

All these things and many more contribute to a sense of identity for the visitor. Even the kind of employees in attendance has its effect: the use, as personnel, of elderly men who themselves were Otsego County farmers or blacksmiths or storekeepers, instead of overconscientious or elaborately costumed guides primed with a set spiel. Finally, there is a bare minimum of "hands-off" policy; people are encouraged to try riving a shingle or gouging a dough trough.

These are some of the elements essential to personal identification for the eighty per cent of our visitors who are just passing through and perhaps would not have stopped at Cooperstown in the first place if it had not been for the Baseball Hall of Fame. Some of them, I imagine, are unimpressed. Some, I know, become completely fascinated. From their remarks, and the letters they occasionally write back, a number seem

Fig. 20. Seminar students on the front yard of the Lippitt Homestead. This pioneer home was built in nearby Hinman Hollow by Joseph Lippitt in 1797, eleven years after Judge William Cooper had founded the village which bears his name and which his novelist son made famous.

Fig. 21. Barn and outbuildings of the Lippitt Homestead. The post-frontier round of daily chores is still carried out: milking the family cow, feeding the fowl, and caring for the pigs, horse, and the team of oxen.

Fig. 22. Loft of the Lippitt Homestead, where the children slept.

Fig. 21

Fig. 22

to take away a quiet sense of pride in belonging to a folk tradition which they had perhaps been a little ashamed of and which they never suspected had such deep roots in their country's past. About one in every five returns for another look.

For the next level, the ones who want to come back for all we can give them or who were more than casually interested on their first visit, the Association sets aside two weeks every July for its Seminars on American Culture. This is when the story of the frontier influence can be told in greater depth. Attended by men and women from all parts of the country and all walks of life, these workshop-lecture courses have consistently emphasized folkways, folk art, folksong, and folklore: not only what the traditions were and how they stamped the national character, but where they persist in contemporary America. The scope, which extends in one direction to provide students with first-hand experience in such frontier skills as weaving, cooking, furniture making, building, and farming, extends in the other direction to encompass such varied folk phenomena as jazz, immigration, and the changing tides of taste, tides which, in our own day, have thrown up such flotsam as The Lightbulb Angel.

There are still other levels on which the Association tries to tell its story. Its school program is one of the best organized and most important of its activities, for from the three or four hundred school groups which filter some 20,000 boys and girls through the museums every spring, and from the 7000 New York State junior and senior high school students who, each year, become Yorkers (junior members of the Association), develop the professional and amateur historians of tomorrow, men and women with a living sense of the American past. For those who are already experts in our field (art historians, conservators, and curators) there are Conversational Weekends at Fenimore House during the winter: concentrated symposia devoted to such problems as the attribution and iconography of primitive paintings.

On all these levels, we need to expand our audience and improve our presentation. We need to encourage better prepared school groups, and to expand the Conversational Weekends to include the best of the frontier historians as well as experts from the art world. We should devote much more staff time to research, and use our findings to put our segment of the frontier into historical context through background exhibits at Fenimore House which will tie in organically with exhibits at The Farmers' Museum and The Village Crossroads. We need to get rid of superfluous objects, to clarify our message, and to concentrate more and more on evoking the human being behind the object. We need more extensive crafts demonstrations and a long-range publications program. Like every other museum, we would like to maintain our attendance

figures; gate receipts allow us financial leeway.

But the purpose of almost all these improvements (our primary goal, our mission) is to change as many people as possible from tourists into Americana enthusiasts, from casual passers-by into interested amateur historians. To do this, it is not necessary to add a lot of extra buildings to The Village Crossroads or put costumes on our crafts demonstrators. We would like a church, and perhaps a mill, but have no elaborate plans for expansion. The crux of our message is precisely how much of what counted most in the American experience was unspectacular.

We cannot provide enchantment, but we do have the advantage of a story to tell that encompasses folk life in all its manifestations. The historical process that we are best suited to recreate is one with which people can identify personally, because it proceeds backward, starting from the present—starting, say, with The Lightbulb Angel.

The Situation of Museums in India

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In 1947, with independence and partition safely achieved and with the machinery of a democratic government ready to be utilized, India's statesmen began to apprehend the magnitude of the tasks ahead. In the effort to achieve better standards of living, should the answer be all-out industrialism or the Gandhian return to the rural simplicity of self-sufficient villages? A number of governmental plans were put into effect after it was realized that provision must be made for a bold and comprehensive program of over-all economic development. The success of the first Five Year Plan speaks for itself. In the spring of 1956, India looked back over nine years of independence and more specifically the fruits of the first Five Year Plan. Its leaders were gratified that most of its aims had been achieved and in important fields exceeded. In May of 1956, the final draft was prepared for the second Five Year Plan, which called for the expenditure of about twice the sum that was spent on the first—about $16,250,000,000. Of this huge sum one-third was to be spent by private enterprise in the manufacture and distribution of consumer goods. Of the remaining two-thirds the government was to spend fifty-seven per cent on power projects, heavy industry, minerals, and transport, which would leave less than one-third of the total budget for work in education, public health, and land problems.

Over the past few years symptoms of old age and hardening of the political arteries have appeared in the governing Congress Party. The most dangerous development has been India's economic deterioration. The second Five Year Plan has faltered as it became evident that one billion dollars would be needed in foreign aid to carry it through. The distinctive element in the Indian situation has been a large increase in the population without the development, at the same time, of an economic productivity to keep pace with the people's needs.

In the summer of 1958 I was asked to visit India under the auspices

of the Office of International Educational Exchange Service of the United States Department of State to act as an adviser on exhibits for six months at the new National Museum of India that was under construction in New Delhi. While in India I also had the opportunity to visit twenty-four regional, state, and archeological site museums located throughout the vast subcontinent. The present article is based on my first-hand observations and discussions with Indian museologists. It is certainly not my intention to be overly critical in this review or to cast any particular aspersions upon the Government of India or its museums. Much of what I deplored there I have seen in many other countries, including the United States. Thus my sincerest hope is that my opinions and observations will be taken in good faith and that they will be of some help not only for the museums of India but for other museums as well.

Does India, with a population of four hundred million people, want its masses to visit its museums for general educational enlightenment, or does the government want to retain its great repositories for the exclusive use of research scholars and sophisticated gentry? India is not alone in having to make a decision regarding its museums. With more people visiting larger collections than ever before, in all countries, the museum's need to redefine and clarify its function is urgent. Nevertheless, this basic question must be answered by Indian educators and the policy makers of India's Five Year plans. Up to the present time, most major efforts of the leaders in India have been in the general direction of embracing modern technology and industrialization.

The collections, staff, and administrative philosophy of the approximately one hundred and fifty museums in India were established by the British in the early 1900's and have changed little since. Indian museums, like ninety per cent of the museums in the world, are principally storehouses of antiquities and oddities of nature, and the "museum" as it is perceived in reality by the general public throughout the world is a dingy structure containing dingy objects that are piled on top of one another much as in an attic or storage cellar. Of all the sources of public education in the world today, the museum is probably the most neglected and the least supported, and its full potential is the least appreciated or realized.

India is a new nation, just twelve years old, but it has a cultural tradition that goes back thousands of years. It is also a vast country with a large population that is as culturally and linguistically diverse as are all the populations of Europe together. With this basic raw material, plus the thin overlay of British culture and tradition, India set forth in 1947 to build a new life and to compete economically in a fast-moving world of science and technology. To remake a simple agricultural nation fragmented internally by both cultural and linguistic differences, with a

nation-wide illiteracy rate of eighty per cent, presents many difficult problems to leaders whose main aim is to lift their country into an age of enlightenment and economic independence.

Some readers may react violently against even the mention of the difficulties of museums, when millions of people must be fed, social reforms must be effected, farm production must be increased, monetary and foreign currency exchange problems must be solved, health and birth-control measures must be taken, and countless other crises must be faced and resolved, first. But to deal with any of these problems, some sort of initial enlightment or education is essential, in order that the plans and dreams of India's leaders may come into being. For this reason there is a need to analyze the role of the museum in India.

The world is eagerly looking to India, watching to see how efficiently she can manage to become a "modern" nation without enduring the long growing pains of the West, to overcome age-old traditions and rigid patterns of life, and to change an archaic, devoutly religious, agricultural nation into a modern technological society with a sound economic base. The role of education in these long-range plans is, of course, taken into account by her leaders but it is here that they have neglected a very great potential in their planning, namely, the museum.

Through audio-visual means many educators hope to speed up the process of learning. Such means have been very successful in many school systems and among a few museums in the United States and Europe. The progressive museum, with its three-dimensional "teaching" aids, can fill this need for accelerated learning in many underdeveloped countries. But foremost is the necessity to define just what a museum is and how a museum functions.

The dictionary definition of "museum" corroborates without a doubt that the museum, as it is commonly regarded, *is* "a temple of the Muses, hence, a place of study or a building, or part of one, in which are preserved and exhibited objects of permanent interest." Archaic as this definition may seem, there are many great institutions in the world today which still act principally as repositories of collections, be it in the fields of art, science, or history. Unfortunately too few of these institutions are fulfilling their basic obligation to the public that they serve, namely, education. Basically such repositories are of value only to the scholar or to the initiated few who have a background in a specific subject. Other visitors may appear to show interest in the collections that are on view, either out of idle curiosity or for amusement, or they may even have entered the sacred halls just to get out of the rain.

The main function of a museum should be education through the interpretation of its collections, in addition to the preserving of and the adding to its collections. Interpretation, the most important aspect

of any museum, is achieved through scholarly monographs, popular publications, guided tours, adult education programs, and all-day programs; but primarily it is achieved through its exhibits, because it is through them that the largest number of people is affected.

At the present time museums in India are largely under the direct control of the central government or state governments, who have chosen scholars rather than educators as administrators for these institutions. Furthermore, it is significant that the Ministry of Scientific Research and Cultural Affairs, rather than the Ministry of Education, has charge of the administration of museums. Also, by many ministry officials museums are still believed to be specifically for scholars and their research. Of the one hundred and fifty museums in India, nine are sponsored by the central government (which include archeological site museums). Most of the remainder are run by the states. A few are private. Each scholar is, of course, interested only in his respective collection and what it means to other scholars, thus limiting the range of over-all interpretation. The interpretation of the museum "treasures" to the general, interested public is usually entrusted to a subordinate whose main attributes for the job of "guide-lecturer," in a museum of art or archeology, for example, are that he has had a course or two of Indian history and is rather well versed in Hindu mythology, epigraphy, and numismatics. He explains to his small audience intricate and disjointed facts about some of the objects on "display." The patient Indians follow their guide between the cluttered cases and peer into the jammed unlit interiors. After an hour or two of receiving concentrated bits of unrelated information, the visitors leave, little the wiser as to the why's and wherefore's of the grand cultural heritage that is India. This regrettable situation is the rule.

Except for five major museums in the larger cities, most of the Indian museums are two- or three-man "operations." The small museums, which in most cases have excellent though limited collections, as well as the larger and more diversified museums, have not made many efforts to utilize supplementary materials, such as graphs, charts, maps, photographs, and reconstructions, so integrated that the material on display speaks for itself. In any museum in India, large or small, the uninitiated visitor is left to his own devices and with whatever limited background in subject matter he may possess he must, perforce, supply some semblance of meaning and unity to what he is viewing. Museums are crowded with objects beyond the point of reason, owing in some cases to the fact that little or no storage space is available. But in most museums the director or keeper in charge feels that he is under an obligation to show off his entire collection, regardless of the space that is available. "A museum without a lot of objects on display is not really a museum," is the common

opinion of most Indian museum directors.

Another disheartening sight is the neglected and faded specimens, or objects that are badly repaired, with no apparent thought to craftsmanship. The main reason for this unfortunate situation is that there are only a few trained people available to handle the technical problems of restoration and preservation. Only three museums in India have a trained staff, with equipment, who can undertake this type of work. Another reason for the deplorable condition of some museum specimens is that the staff in charge often neither cares about nor realizes the value of the objects in its charge. A third reason is that many of the objects are not in dust-tight cases and are also exposed to extremely bright sunlight, which in India in a short time reduces delicate museum specimens to dust.

Added to the depressing picture of the state of Indian museums is the very poor design of all the museum buildings, including four only recently built. The old museum structures all outlived their usefulness many years ago and are completely inadequate in their present state to function as educational institutions. There are little exhibition space, no adequate storage facilities, inadequate offices. A few museums do have auditoriums, or rooms that could serve as lecture halls. However, there is just a general lack of space for everything. As is mentioned above, all the museums, including the new ones, have vast areas of windows which let in the hot Indian sun, which is most detrimental to paintings, textiles, and mounted bird and mammal specimens. The new National Museum in Delhi is presently bricking up its windows so that a modern lighting scheme will be more effective. Most of the other museums must rely on full daylight for illumination, or revert to a few low-wattage bulbs when days are dark and overcast. In designing its new museums, India missed a great opportunity by not letting some of its young, progressive architects express themselves on such projects of national importance. Instead, the buildings were designed by traditionalists already in the service of the government, who made sure that the buildings looked "Indian," a neo-Victorian-Moghul architectural style in red and tan sandstone.

The world-wide trend towards relating the great wealth of content in museums to the needs of people in all walks of life, and to furnish intellectual, social, and cultural opportunities not merely for scholars but for everyone, has accelerated greatly since the end of the last World War. Stimulated by the needs of ordinary people, a few museums in various parts of the world have become the newest as well as one of the most effective means of popular education. They reveal to people the extent and importance of their culture; they explain, and they expand the understanding by people of, their present way of living; and they show paths of advancement that no other means can convey. What is being

started elsewhere can be done in India, and the establishment of a modern museum philosophy designed to promote the welfare of the people of India can well spread from its cities throughout the whole country.

The visitors to the museums in India are a cross section of the whole population. Whether the people are rich or poor, educated or illiterate, young or old, they go to museums, wherever and whenever they are open; they go even when there are small entrance fees. What benefit they get from going is another matter, and it is obvious that for many, the main result is a kind of temporary sensory stimulation and the satisfaction of a passive form of curiosity. One may well wonder what people can get from a museum when their own backgrounds are unknown to them except in a narrow, word-of-mouth history passed on from their elders; when they know little, if anything, of any part of the world beyond that of their immediate experience; when their acquaintance with any form of living other than their own is practically nil.

The general needs of the great majority of the people of India are well known—in health, in sanitation, in industry, in agriculture. In these and other areas, the needs can be met only through education. Many educational paths exist for the literate, and the symbols of reading can supplement many other forms of communication, but for the illiterate, the paths are few and narrow. Some possible means of communication, such as radio, are barred, because illiteracy often accompanies economic poverty. Many of the young people are fortunate, and can and will go to school, and their number increases from year to year. For the older people to have had formal schooling is more rare. What these people need most desperately is an education in the techniques of living that in some way will bring them into the present-day world so that they can live better, healthier, and more human lives. They cannot get it in school; they can get it only through some means that will tell them what kinds of living are possible and how they may be found. Such a high purpose could be served through the country's museums. India is thus missing a grand opportunity in facilitating its objectives in mass education such as are exemplified by the Adult Literacy Plans that are being carried on in many villages.

Some critics may then ask, What is going to happen to all these "educated" people? It has already become difficult for some of them to get jobs, for it is a truism that people with a general awareness of the outside world usually become dissatisfied with their own pinched position and lowly status and dream of a better life with greater social prestige. At present, farmers are leaving the fields to find fortune in the cities, at a time when one of the prime problems in India is feeding its population without outside help. With proper education, schools, and especially the

rural museums, through visual presentations, could point out the value of the farmer as a food producer to the general economy and welfare of the country and urge him to remain on the farm and strive for greater crop production through more advanced agricultural techniques.

Unfortunately the present governmental bureaucratic system has many weak points, which many of India's leaders admit. A tendency to shift key personnel from ministry to ministry or from one specific job to another within the ministry is very detrimental to the proper carrying out of long-term projects. As a prime example, no one connected with museum administration in the Ministry of Scientific Research and Cultural Affairs knew of the work carried out in Mysore by UNESCO in 1953–1955 on "Museum Techniques in Fundamental Education." The Mysore work was an extremely worthwhile undertaking, which could have been a valuable experiment in general education for a vast illiterate population, but so far as I know nothing further has been done regarding it. The whole problem of the role of museums in India comes down to one main point: a lack of insight and direction by the state as well as the central governments, which do not yet possess the experience and knowledge to carry out a long-range program plus a general ignorance of the role and function of the "progressive" museum. The administrators of funds in the state governments and in the Ministry of Scientific Research and Cultural Affairs in the central government are given poor advice by so-called "museology experts," Indian scholars, who may have spent only six months or a year visiting museums in Great Britain and Europe and have for the most part limited ideas as to the potentials of well-planned educational museums.

A striking example of misguided advice is the fact that the Indian Government has allocated a large sum of money to refurbish and rehouse the Salarjang Museum in Hyderabad. This collection of primarily third-rate European arts and crafts, and lesser arts and crafts of Asia, was accumulated by a relative of the one-time Nizam of Hyderabad. European art dealers took advantage of this arduous collector and of his Oriental tastes and sold him the works of unknown artists and craftsmen, just as unsuspecting and ignorant American and European travelers in India are often sold fakes and outright junk. His palace was thus filled with rugs, porcelain, chandeliers, metal work, sculpture, and paintings, for which he paid huge sums. This collection is now to become a "national" museum. This ostensible national treasure house, with its jumbled and unrelated collection of European objects, will certainly present a false picture of European artistic achievement to the sophisticated Indian visitor who has never been abroad. The man in the street, who will stare wide-eyed at these "fabulous treasures," will be dazzled but in no way the wiser as to the ways of European life and culture and

its development. In making the Salarjang Museum a national museum, the central government is exposing itself to strong criticism from European art historians and museologists. I am positive that the money that is to be used for this could have been put to much more valuable use if responsible advice had been sought.

So unfortunate a decision points to the problem of the foreign expert, or adviser, who is engaged to analyze a situation and to offer concrete workable solutions for it in underdeveloped countries. Great danger here awaits, and can actually hinder, the basic objectives of any project. Often the host country receives conflicting solutions to its problems from various experts, which is indeed confusing, and one cannot blame the country for deep suspicions about any future outside assistance. It is, therefore, essential that the host country and the country that is to supply an adviser analyze the basic problem in great detail and progress slowly and logically to a workable solution. Preliminary analysis of the problem can be undertaken by extensive correspondence, which would save valuable time and money. It is also important that once the expert reaches his destination he should point out areas where the underdeveloped country could actually help itself, especially with regard to equipment and personnel. One hears of shameful advice to buy supplies or equipment from the United States or Europe, when locally made equipment would have done the job almost as well. After all, it is not the task at hand to recreate on foreign soil the same workable conditions and atmosphere of an American Museum of Natural History or a National Gallery of Art. The basic objective is to assist in the best way possible the operation of a museum (in this case) to fulfill its basic obligations to an uneducated public with the use of local materials and personnel.

General museum training in India also stresses scholarly pursuits rather than educational activities and methods of visual communication. Baroda University is the only exception; there stress on education is almost equal to that placed on scholarly endeavors. The museum training program at Baroda is doing a magnificent job under all kinds of hardships and obstacles. Courses in museum technology, exhibit preparation, and educational philosophy, plus the required academic subjects, are offered.

At Calcutta University, where there is also an academic program in the field of museology, less than one-tenth of the course work is devoted to education and less than one-twentieth of the student's time is used for the study of exhibition display and problems in visual communication. As a result of such training and its scholastic orientation, most of the students leave the universities to take positions in museums where they will carry on the old English tradition of antiquarianism and pseudo-scholarly research.

India is definitely at a point where it must reëvaluate the importance of its museums. The opportunity to use the museum and its collections for educational purposes should be seriously considered by all Indian educators, and certain demands should be put upon the central government as well as the state governments. To show off its national treasures, i.e., paintings, sculpture, archeological specimens, and coins, as ends in themselves is pure luxury in a time of great need. These collections, as well as anthropological, historical, and natural history collections, should be used in the telling of a much greater story, the cultural, historical, and scientific (geological and biological) history of India. In this way the museums would fill a large gap in general education and fulfill the basic obligations of museums to the public. If a small museum does not possess a staff talented and knowledgeable enough to interpret and exhibit its collections adequately, there is no reason why it cannot go beyond its own walls for help. If a city or town is large enough to have a museum it usually has a university as well. What, then, is to prevent the keeper, or curator, from seeking aid from the local university in obtaining scholarly knowledge or scientific experience in preparing a story outline for an exhibition? By the same reasoning the keeper can also receive exhibition designs and layouts from the art and architecture departments of the neighboring university, which could even take on such a challenge as a class project. In this manner the small museum and the university, working in conjunction, aid each other and the community as well.

To install an exhibit that follows contemporary museum ideals is to show or tell a story in a step-by-step progression, with the use of a museum's basic collections with supplementary material, such as reconstructions, charts, graphs, maps, and photographs, so that the total effect is stimulating and meaningful. It is not possible, for example, that the average museum visitor will have the same enthusiasm for a small line drawing or bronze figure as a scholar. But if that average visitor can be led to realize that the drawing or the bronze figure reflects the culture from which it came and its relative importance and use in that culture, a minor victory for the museologist has been won. By answering the questions how, when, where, and why in a simple and uncluttered manner, such museum exhibits will convey to the public a hitherto unimagined role of the museum. No concept or theory is too difficult to interpret to an uninitiated mind of any age, if the concept or theory is elucidated in terms of the viewer's experience. The museum can and should be an exciting place to visit.

The main task at hand for the new museums of India is to draw the public within its walls and to reëducate them. This reëducation should at the same time help to dispel erroneous notions of what a museum is, namely, a graveyard of objects.

Pottery Restoration

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The problem of pottery restoration first came to the writer's attention back in 1930, at the time Dr. S. A. Barrett, then Director of the Milwaukee Public Museum, was preparing his monumental work, "Ancient Aztalan." A particular lot of broken rim sherds had been isolated from the items found in a refuse pit, sherds that were decorated in a pleasing manner. It appeared that enough pieces were present for a restoration of the rim of the original vessel to be attempted.

Detailed examination proved two points. First, the numerous sherds represented more than one vessel. Second, several fragments were sufficiently large to suggest the extension of the body below the shoulder.

With these facts at hand, it was possible to project the form of one of the vessels and prepare a clay base for restoration. A projection of the rim pieces suggested the over-all shape and the relationship of the several fragments for positioning. Restoration was thereafter performed by the laborious process of placing the sherds on the prepared base, pouring on plaster to replace the missing area, scraping or cutting away the surplus, and then finishing the restoration. Such would have been a satisfactory process had this been the only example from Aztalan. As it developed, subsequent examination revealed that there were many additional vessels represented by individual sherds which had the essentials for satisfactory restoration, even though certain pieces represented as little as five per cent to ten per cent of the original pot. To project each, to model the form by hand, to cut away excess restoration plaster, and to finish each piece by the process originally attempted would obviously be too time consuming. A shorter, more satisfactory means was needed. Such was developed, and thereafter several dozen restorations were made, not only for us but also for other museums. Requests for information about the process have been answered locally, but, for the greater part, the technique has not been widely publicized. The following information

should sufficiently explain the process, so that technicians anywhere may be able to prepare satisfactory restorations.

REPAIR

The first step in restoration is the assembly of available sherds. In instances all portions, although fragmentary, are present. In such a case the job is really one of repair. It is in the replacement of missing portions that one may be said to be doing restoration.

Sherds are usually dirty, so that they should be washed. Generally a careful rinsing with lukewarm water will suffice; in some cases a fine brush may be used to aid in the removal of adhering particles of foreign matter. After they are dry, the assembly of the fragments can be attempted.

While there are several satisfactory cements available for the joining of the pieces, we have found the product called Ambroid (colorless grade) very satisfactory. It may be thinned or removed with C. P. acetone as needed. Do not use the Technical acetone, as it tends to make the cement cloudy. Insist on C. P. *Caution!* Acetone is very inflammable; do not use near fire or flame; have adequate ventilation.

Occasionally one has potsherds that are soft or brittle. In such cases the fragments may be soaked in a thin, watery solution of Ambroid and acetone. When bubbles cease to rise, the piece is thoroughly impregnated. Dry the sherd by placing it on a piece of paper towel or cloth and wipe off any shiny residue with acetone.

Such soaking will harden the sherd appreciably and also make it waterproof. Pieces that are intended for laboratory testing for physical characteristics should not be so treated.

Fragments are then fitted together to determine joints. This is a matter of experience and luck. Designs, surface peculiarities, and thickness may help. When a joint is determined, mark it on the reverse with a crayon so that the positioning can be repeated more readily for cementing. It is amazing how easily a joint can be lost after the cement has been applied and one subsequently attempts to refit.

Cement is applied to the edges to be joined, and the pieces are fitted together. Excess cement that oozes out may be wiped across the joint. On the inner surface such smearing serves as a strengthening bond; on the outer, it ultimately is unsightly. To correct the latter, wipe with acetone after drying. The surface will again assume the characteristic dull finish.

The assembled pieces are next placed in a sand box, a tray with a two- or three-inch layer of sand in it, where the unit, properly supported, will dry in correct position. Any sand that adheres to the cement can be removed with acetone. Drying is usually a matter of not over a half

hour. In the meantime other assemblies can be made.

Ultimately relatively large units can be united, and major portions of the vessel can be produced. Here it will in all probability be noted that curves are not true or that fitting is impossible for a variety of reasons. Such discrepancies call for either the softening of the joints for readjustment or the removal of some piece for more convenient assembly into another major unit. The brushing of acetone on the dried joints will soften them so that they can be taken apart or, if desired, spread or compressed to fit.

Another advantage of the use of this cement is the fact that the operator may at a later date disassemble the repair, in case his technique has arrived at the point where he is able to do a better job. It can always be done over, even after many years.

If the entire vessel is present, nothing more is needed but the removal of undesirable cement on the outer surface. The inner surface may be painted with slightly thinned cement, if desired, which gives additional strength. If small areas are missing, they can be restored according to the instructions that are given below.

RESTORATION OF SMALL AREAS

After all available sherds have been assembled, it will be determined whether any portions are missing. Almost invariably some area is absent. Such a piece should be restored. Here additional materials come into the picture.

For small patching, ordinary plaster of Paris can be used. This is first mixed, dry, with color, such as powdered burnt umber. Avoid soluble colors, as they either bleed or dry irregularly. A reasonably uniform color in the finished product is desirable. Uncolored plaster generally leaves a whitish cast on the pottery surface which is hard to remove; hence the recommendation of color. Thorough mixing and sifting incorporate the plaster and color. A small mixing bowl, possibly an old teacup, will serve later. Before using the bowl or cup, wipe the inner surface with a bit of oil, which will serve as a separator and permit waste plaster to be removed easily.

Now to the process. Take a small piece of Plasticine or other nondrying plastic modeling clay and pat it into a "pancake" of sufficient size to cover the missing area, allowing enough for an overlap of at least an inch. This pad is placed on the inside of the pot, covering the opening to be filled. In case the vessel is of a thin ware, apply the pad in such a manner that the plaster, when it is poured into the hole from the outside, flows a bit along the inner surface of the vessel. This will aid in anchoring the plug, lest it fall out later. Thick ware, such as woodland stone or grit-tempered pottery, normally has so rough a broken

Fig. 1

Fig. 2

edge that the plaster will adhere well by itself.

With the clay dam in place, the plaster can be mixed. A quantity of water, more than will well fill the opening, is measured into the cup, and the colored plaster is added slowly. Using a spoon, drop the plaster on the surface of the water until the water has absorbed as much as it will take. Less will be chalky; too much will set too fast before proper mixing. Here experience counts. Mix the plaster well and, after about one minute of mixing, tap the cup on the table lightly a dozen or so times. Bubbles will rise. These are the confined air which should be removed. Such froth, along with unmixed powdered color, is skimmed off with the spoon. The resulting mixture is ready for pouring. It will not set for several minutes. Remember, the more the plaster mix is stirred, the faster it will set when one stops stirring.

With the edges of the sherd wet with water, the mixed plaster is next poured into the opening. Be sure that the edges are properly covered.

Fig. 1. Aztalan pot in process. The core was modeled by hand, undersized, and the sherds were placed correctly.

Fig. 2. Colored plaster in place on the core, with sherds anchored.

Fig. 3. The finished vessel, with the restoration lightly outlined and the surface painted.

Fig. 4. Diagram for determining the center of a pot from a sherd.

Fig. 5. Diagram to show how to determine shape of a vessel.

Fig. 6. Diagram to show how the template is fitted.

Fig. 3

A sufficient amount of plaster is poured in to fill the space a bit beyond the surface of the surrounding sherds. Place the pot in a safe position and allow the plaster to set thoroughly.

With the mixing done as recommended, the plaster will be workable for three minutes or more, so no hurry is needed. Once the setting commences, one may allow a half hour or so for proper hardening. After complete setting, the excess plaster can be trimmed off with a knife and, if desired, smoothed with waterproof sandpaper. The sandpapering must be done carefully so as not to scratch. All plaster must be carefully removed from the sherd surfaces. While certain operators approve of sandpaper, the writer prefers to scrape and cut with a knife, believing that the end result is smoother. Also, a knife can be controlled better.

After satisfactory dressing and washing to remove scrapings, the restoration is allowed to dry, and the vessel is ready. Any reasonable number of patches can be applied to a pot. If there are very many, it is advisable to brush the inner surface of the vessel with thinned Ambroid to strengthen the restorations.

A word of caution should be given regarding the disposal of plaster. If any considerable amount of work is anticipated, be sure to have a trap in the sink drain, in addition to the usual crook in the pipe, to catch the particles that are washed off in the finishing process. The plaster must have a settling tank, or it will ultimately fill the sewer pipe. Such traps are intended for grease, but serve excellently for plaster also.

MAJOR RESTORATION

Before techniques are discussed, it is best to consider the materials and equipment that will be needed. Plaster, hardening agent, projection equipment and its application, forming devices, and over-all operations

Fig. 4

Fig. 5

Fig. 6

must be clearly in mind. While all this appears to be quite formidable, nothing is beyond the capabilities of any practical technician.

For major restorations it will be found that plaster of Paris, purchased in small quantities, is quite expensive. A fast-setting molding plaster is recommended. This is really a commercial grade of plaster of Paris, available in ninety-pound bags, at a fraction of the cost. It will keep indefinitely in a dry place. Colored plaster mix should be prepared in ample quantity. Such plaster is to be mixed later with a hardening agent, as it otherwise is too soft and chalky for permanence.

Numerous hardening agents are known, but the simplest is a water solution of dextrine. The powdered dextrine, a starchy material, is mixed with water and stirred. After settling, which means that an excess of dextrine has been mixed, the solution is ready. Use one part solution to two parts of water for plaster mixing.

Water clay in quantity is needed. This should be of modeling consistency.

Projection equipment, consisting of a mechanical drawing set and possibly cross-section paper, is necessary for lineal depiction of the vessel to be restored.

A turntable and template serve to develop the ultimate form of the desired restoration. A sketch of the table is shown (Fig. 7). The dimensions are ample for most restorations.

The essential requirements in the major restoration of a pottery vessel are: (1) one or more horizontal curves from which to determine the

Fig. 7

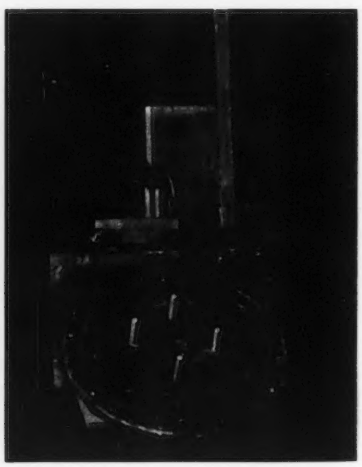

Fig. 8

Fig. 9

Fig. 10

Fig. 11

Fig. 12

Fig. 7. Diagram to show construction of turntable.

Fig. 8. Turntable assembled for use. The wooden template is in place on the upright. An auxiliary board is in place on the disk, with dowels close to the center to accommodate a small pot. An extra disk shows the center hole and the placement of the dowels.

Fig. 9. A clay form on the turntable, partly turned, showing wooden template in position.

Fig. 10. Finished clay form, with sherd in place and gobs of wax added to prevent later slipping of sherd in mold.

Fig. 11. Hollow mold. All clay has been removed, allowing the sherd to remain in place.

Fig. 12. The cast partly exposed. Two layers of plaster mold are visible.

diameter, and (2) enough of the vertical curve to illustrate the outline from the lip down past the shoulder. With these present, a sherd representing ten per cent or less of the vessel may be sufficient to permit a reasonably accurate restoration.

Figures 4 and 5 illustrate an ideal example. A sufficient amount of the rim and body portion is present for the diameters at several points to be determined, and also the vertical profile is quite evident. A typical diameter is arrived at in the following manner. With the use of a strip of plastic clay, the rim curve is impressed. A substantial "bar" of the material is advisable, to avoid distortion. The curved "bar" is placed on a paper, and the curve is transferred with a pencil. The accuracy of this step will later be reflected in the accuracy of the restoration. By the simple process of subtending the arc (Fig. 4) that has been drawn, a center will be arrived at. Remember that all examples are not as ideal

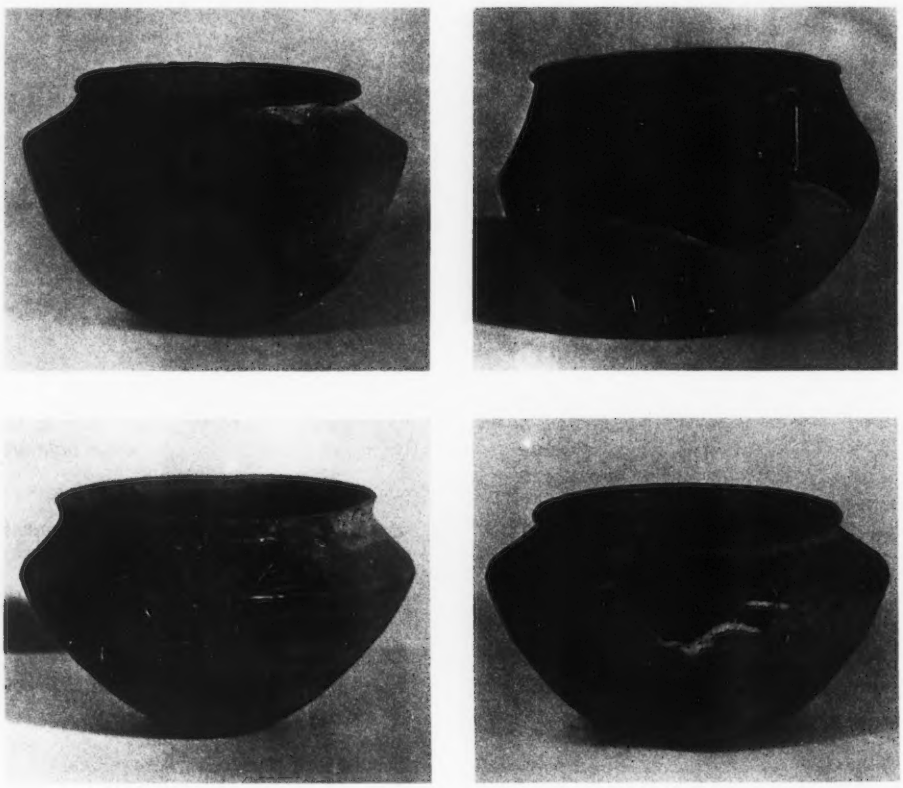

Fig. 13

as the one illustrated; therefore, with the use of a number of chords and their perpendiculars, an assortment of possible centers will be noted. Here experience and judgment again aid, this time in the choice of the most acceptable center. Because the pottery was not made on a wheel, irregularities in curves are the rule. A true common center is obviously non-existent. The closest approximation must be used.

At least two curves should be thus projected. Again ideally, the rim and the shoulder, at established and recorded points, will furnish the needed dimensions, which are the horizontal radii at those points.

The vertical profile next needs to be recorded. Similarly, with a heavy plastic clay "bar," an impression is taken of the vertical surface. This is also sketched and then cut out of the paper for later possible use.

If a sufficient portion of the rim is available, an alternate technique can be used. The sherd is set in an inverted fashion on a board, and clay is applied both to the board and to the vertical section, with the sherd held in its most nearly correct position relative to the board. The "angle" of board and vertical is important and, if it can be thus obtained, ideal.

With the use of the latter method, the "angle" obtained is sketched (Fig. 5) on a base line, AB, the "angle" AEG resulting. The radii previously obtained now are used to determine the correctness of the "angle" relative to a vertical, CD, which, if the vessel is ideal, will have the correct radii at the points previously taken.

If it is impossible to arrive at the correct "angle" by the method previously noted, the cut-out pattern is placed at E at the radius for the rim. The pattern is now tilted until the remaining radius or radii agree relative to the line CD. The position of the profile is now determined. By doubling the radii or, better, folding the paper on the line CD, the curve EG can now be sketched as a mirror image by transparency technique. The result will be, on line AB, the balanced curves EG and FH, representing the projection of the available portion of the pot.

A cross section of squares is now drawn, or cross-section paper is used, balanced on line CD, and the base of the vessel is drawn. The basal curve will depend upon the type of ware and should conform to known lines. The finished projection is a vertical section of the vessel, following the outer line EGDHF.

The outer line EGD is now used for the preparation of a template. This may be made of wood, if desired, but an oversized pattern with an inner sheet-metal addition is more accurate.

Fig. 13. The varying amounts of original sherd that are needed for a satisfactory restoration.

The curve EDG, previously noted, is marked on the sheet metal, and the plate is then cut out. A thin galvanized sheet, easily cut with tin shears, is satisfactory.

Within the oversized board (dotted line, Fig. 6) the template should be fastened with nails so that the curve AB, the outline of the vessel, is free and sufficiently away from the wood. The cut CB is made wider than the thickness of the rim, as strength may be needed later in the cast. Any excess thickness of plaster can be cut away subsequently as desired. The riser CD allows clearance in later turning and also aids in the pouring of plaster, assuring a sufficient flow at the rim.

The turntable (Fig. 7) is now called into play, and a more detailed reference to its construction is in order. At one corner of the box a two-by-four upright is bolted in such a way that one of the surfaces is in direct line with the center of the top of the box. In the center of the latter a pipe flange and a short length of pipe are fastened to serve as a pivot. It is recommended that three casters be put on the box for the free support of the disk. The disk, cut of a piece of five-ply, one-inch bellow stock, has a hole drilled into its center to fit the pipe on the box. Three holes are drilled near the center of the disk, fitting similar-sized dowels. The entire disk could well be covered with a plastic sheeting, such as celluloid, to avoid contact between the wood and the water clay later to be applied. The finished disk will be centered on the pipe and will ride on the casters.

With the turntable ready and the template prepared, the latter is fastened, with G-clamps, to the upright so that the rim is its correct distance away from the center and the base (top in this case) its correct distance above. In other words, the vertical line CD (Fig. 5) should be perpendicular, and AB (Fig. 6), the curve, with the addition of the riser CD, should be properly positioned as a perfect half of the vessel.

Water clay is next applied to the disk, the dowels near the center serving as anchors for the mass. An assortment of positions for these dowels may be needed to serve variously sized pots. When a sufficient amount has been placed, the wheel is slowly rotated and the excess clay is cut away. Continuing the process will result in a clay form that corresponds to the projections previously made. The template is now carefully removed, and the form is allowed to stand free.

The available portion of the original pot is next placed against the clay form, and its outline is scratched into the clay. Clay within this outline is excavated until the sherd fits into the space and its surface corresponds with the surface of the form. Clay is used to fill any spaces along the edges of the sherd.

If the specimen is ideal, the continuity in surface will be satisfactory at this point. Generally, owing to the irregularity of primitive pottery, some

additional modeling is needed to complete the form at this stage. It may be necessary to add or remove clay locally. When all is finished, the clay form, with the sherd in place, is sprayed with water and carefully smoothed with a camel's-hair brush. In this condition the form will survive safely for half a day. If it must stand until the next day, cover it with a number of layers of wet cloths to prevent excessive drying and resulting shrinkage.

A mold is now to be made of the form. To provide an anchor for the sherd within the mold, apply several gobs of sticky wax[1] to the dry surface. The molding plaster will surround the wax gobs and prevent the sherd from shifting within the mold.

Be sure that the sherd surface is wet with soapy water or clay water when the mold is made.

Plaster is next mixed plain and poured over the form. Any excess that

[1] A good composition is: white beeswax, three parts; Canada balsam, one part. Melt wax and add balsam. Mix. Let cool. The result is soft and sticky.

Fig. 14. Restored bottle. This piece was formed with the base down, and the cast was made through the bottom opening, which was later filled with plaster. Such an adaptation of the basic technique is occasionally necessary.

Fig. 15. Restoration showing raised bosses on the rim. A sufficient riser is needed in such a case.

Fig. 16. Restoration of a vessel with a pentagonal rim. The template in this case was made to shape a normally rounded rim, and later modeling of the clay form was done by hand before molding.

Fig. 14

Fig. 15

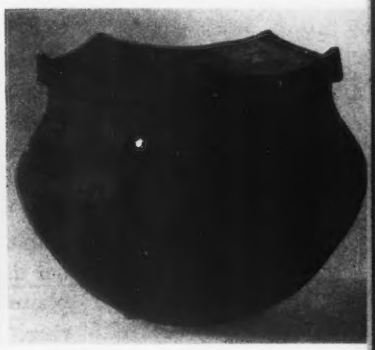

Fig. 16

flows down and away may be replaced on top, although the layer of plaster should not be thicker than one-quarter of an inch, preferably a bit less. When it is set, brush the surface with clay water or soapsuds and add another layer of plaster. This layer may be one-half an inch in thickness. A small pot will need no more plaster for a mold, but a large vessel will need as much as an inch. Exceptionally large pieces have been molded with two inches of reënforced plaster. The separator should be applied without fail between layers of mold plaster for greatest ease and safety in later removal. Some technicians prefer to color the first layer for later visibility. Colored ink added to the water will color the plaster. Caution is advised, as the ink may bleed through and affect the ultimate cast.

When the clay form and sherd are completely encased within plaster, the disk is removed from the table and carefully inverted, allowing the form and mold to be removed from the board. All clay is carefully dug out of the mold. Be careful not to disturb the sherd. Wash the mold thoroughly to remove all clay from within.

The mold should normally have a sufficient amount of clay embedded in its inner surface to serve as a separator, but generally an additional brushing of soapy water on the inner surface is advisable. It does no harm and assures satisfactory separation of mold and cast. Do not apply separator to the sherd.

The proper quantity of water and dextrine solution is poured into a mixing bowl and the premixed, colored plaster is added, this time with a small excess, as the solution does not absorb so much plaster as water does alone. The mixture is thoroughly stirred and then jarred on the table to bring all air bubbles and colored froth to the surface. These are skimmed off.

The plaster mix is next poured into the mold, and the latter is rotated by hand so as to cause the plaster to flow uniformly over the entire inner surface of the mold. Be careful not to allow the plaster to cover the inner surface of the sherd. In the rotating process, allow the excess of plaster to flow out of the mold back into the mixing vessel. If the excess is not thus poured out, it will settle to the bottom of the mold. A sufficient amount will adhere. After a minute or so, experience dictating, the excess plaster is again poured into the mold and the rotating process is repeated. This may be done as often as necessary or as long as the plaster is fluid. Ultimate excess is discarded.

By the above process multiple uniform layers of plaster are built up within the mold, the thickness of each layer being also uniform. Pouring out the excess around the lip of the mold assures a sufficient amount of plaster at the rim of the restoration where it is needed for strength. The riser, previously allowed, assures a sufficient thickness at that point.

A small restoration will not need more than a single such pouring. A larger example may need a repetition of the casting procedure in order that the needed thickness is developed. For exceptionally large vessels, it may be advisable to reënforce the cast with scrim or other loosely woven cloth, embedded in the plaster. Such a need is rare.

The unit of mold and cast is placed where convenient, and the plaster is allowed to set thoroughly. If the casting is done in the afternoon, wait until the next day, but cover the inverted mold with wet cloths to prevent undue drying. The plaster mold is more easily removed if it is moist.

After a minimum of two hours of setting time, after the cast has been heated and again cooled, the mold can be removed. This process is done with a chisel and mallet, one layer of mold being removed completely at a time. Rest the mold on a pillow during this operation. The only place where trouble may be encountered is in the removal of the last layer. The answer is patience and care.

After all the mold material has been removed, the rim can be trimmed with a knife, reducing the riser and thinning the rim to a pleasing thickness. The wax anchors are scraped off carefully, and the area is washed with a solvent such as gasoline. Thereafter the entire cast is carefully washed with clear water, which removes any adhering separator. The finished restoration is then set aside to dry.

Normally no additional coloring is needed. If desired, however, the dried restoration can be painted. With the use of a precolored plaster, painting is generally not needed. Restorations made by this process have been on exhibit for nearly thirty years and show no evidence of failure or deterioration. With careful handling they should survive as long as any plaster object.

Communicating Science in "Four" Dimensions

AXEL HORN, DESIGNER

FOX AND HORN, INC., NEW YORK CITY

AN APPROACH TO A DESIGN PROBLEM

A basic change in the role of the designer is directly related to the unique development of the production and distribution techniques of our time. Although traditionally thought of as tied to a particular craft, he today assumes the versatility of Leonardo, Cellini, or William Morris, but on a level quite different and not as the result of the overwhelming genius that was theirs. At the same time, the term "design" has been so broadened that anthropologists, sociologists, scientists, and engineers find themselves, in certain areas, designers.

Method may be stated thus: The approach to any design problem, whether it be that of an exhibit on science for lay or professional audience, or the setting up of a research study, or the development of a piece of scientific equipment, is a universal one—a type of unified field theory. The ability to establish the nature of the problem and to grasp its limitations and potentialities is a prime talent that characterizes the designer and is a fundamental that can be applied in any direction to resolve any design problem of communication, structure, or function in any field. The diversity of activities of the industrial designer's office is an obvious example. This ability, combined with the utilization of all the technical skills in a particular field, theoretically allows the designer to break through any personal limitation of skill. This may sound like exaggeration. Actually, it explains why many creative people are limited only by the latitude of their interests. If their interests are wide, the utilization of this unified field theory of design permits a wide creative output.

The professional exhibit designer stands in a no-man's land created by the overlapping skills of the field in which he is working: the written word, the visual image, sounds, motion, three-dimensional and multi-reproduction techniques. At a point in the center he stands and draws

on the resources of every one of these skills. He has broken through the barrier of personal skill. He is a manipulator of manipulators of tools. He uses the skilled craftsman as the artist does a pencil, the writer his typewriter, the carpenter his hammer. He is a synthesist of skills.

The design problem is approached in terms of not what *he* can do best, but in terms of what *it* requires. The designer has developed as his skill the ability to break down a problem, to analyze it in terms of its own requirements, and to allow the solution to grow, not by a superimposed ability in any particular skill but from the problem itself. He does not dictate solutions; he follows solutions wherever they may lead. They may lead to the use of combinations of techniques or to single or parallel techniques.

The designer's first contact with his problem is the person or group who requests his services—his client. In a museum, it would be a curator. A personal relationship then becomes the first facet of his projected work. To increase its successful achievement the designer works intimately and directly with this client, not through an intermediary. Discussions give the opportunity for him to evaluate not only the limitations of the problem itself but its relationship to other aspects of the client's activities, the personality of the client, his individual preferences, and his prejudices—not in order to cater to either preferences or prejudices, but to reach through to him in explanations or justifications. He must build a logic for every part of his solution and must be prepared to defend each step with this logic. Initial discussion is a probing. The designer is reaching for his first point of entry into the character of the problem. What actually *is* the problem?

The designer will act as a catalyst by putting into quick visual form or words a starting concept. Even though this may be dismissed later as impractical, it serves as a point of departure and gives direction to the discussion. In very many cases it rests on him to define the nature of the problem for his client. The first step towards solution is that both client and designer understand the nature of the problem in the same way, on the same levels, and in the same terms. The semantics of the situation must be established. Criteria are to be established which give the client standards against which to measure.

Once the problem is postulated and the goals are decided on, techniques and skills are considered in an imaginative way. Tentative directions are established, which lead to further discussions and refinements.

A few of the conditioning factors that a designer must face up to are the following:

A. Audience
   1. Level of familiarity with subject
      (This will be dealt with later in this article)

2. Time allowed for contact

Often presentation is predicated on three possible time spans

a. The spectator who moves by the exhibit at a steady pace without pausing must get the basic message in poster-like symbolism.

b. The interested layman, stopping to examine, will absorb the main details on a caption level.

c. The professional or student must have detailed copy—he will read the fine print.

B. Location of Exhibit

1. Method of contact with audience

Will the audience approach it eagerly as part of a program they have made an effort to get to, or will the exhibit attempt to attract the attention of an unprepared passing public?

2. Traffic flow

a. Will the exhibit attempt to divert traffic or will the normal flow of traffic past it in several directions give it enough exposure?

b. Does the subject require a positive sequence of viewing, or may it be picked up at any point, with all sections correlated in any order?

3. Relationship to other exhibits

How must the other exhibits be taken into consideration? Must there be relationship in color or scale? Is it important to develop impact by a complete change of approach? (It is an interesting fact that for commercial exhibitions in which each exhibit is designed by a different company and designer, each designer starts by considering his exhibit as if it was the only one in the hall. He has no clues as to any relationship and takes nothing except show regulations into consideration.)

4. Mobility of device

a. Must the exhibit travel frequently? Definite physical limitations are placed on it by this requirement.

b. Must it be capable of being rearranged to fit different space requirements?

c. Is it to be considered a permanent installation? Can the designer plan for later adjustment, given adequate field testing?

C. Budget

1. Relationship of preliminary concept to budget

a. Can the designer start with a concept unhampered by budget considerations? Must he start with a budget and work to it?

b. Will the point fixed by a crossing of budget and concept be one that gives enough ultimate use-value to the projected exhibit?

By the time that complete visual presentations are made, all persons concerned have been satisfied that the best solutions have been reached. The design grows out of discussion, experiment, and research. What remains is implementation. At this point skills start to function. The designer's own varied background of skills now becomes valuable. The production of the project is embarked upon. Now one of the most important roles of the designer becomes the setting and maintaining of standards of quality and finish. Not only must he see that his ideas are adhered to,

but he must have the flexibility to incorporate all possible new good ideas brought to light in the process of implementing his original ideas.

THE IMPACT OF RELATED MESSAGES

Let us move one step closer to our topic and talk about communication. Communication is very rarely successful in terms of a single sensation. A telephone conversation, even with an unknown person, is accompanied by a visual image of this person. This image may be established in the listener's mind by the association of the speaker's voice to a voice with similar characteristics belonging to some one he *does* know. Thus, the unknown seems to be thin, heavy, small, large, young, or old; it is rarely a disembodied voice. Even features will be applied in the mind's eye. As a matter of fact, an inability to develop *some* sort of accompanying image will tend to confuse the listener and will make communication less direct and complete. Even inner bodily communication of sensation evokes images that amplify it. A very small child often cannot localize a source of bodily discomfort and experiences confusion as a result. Investigation has indicated that certain individuals find it particularly difficult to visualize situations or objects not directly in sight. These people project and function on a purely oral level. Others have the ability to form vivid images in their mind's eye. These two types find communication with each other more then commonly difficult.

At this point, I would like to project a premise—that the most successful communication is a synthesis of media. It may involve sight, sound, tactile sensation, kinematics, or montage. It might stimulate the spectator to supply a medium himself, such as the utilization of visual after-image, or, by abruptly interrupting a pulsation (visual or auditory), force it to be continued in the mind of the spectator. Communication is enriched as more sensations are involved and as more techniques are combined or brought into play individually. Greater enrichment results in fuller understanding and appreciation by the recipient.

An individual sees an object—a gourd, for example—from afar. He approaches it; he moves away and approaches it from other vantage points. He picks it up, sees the bottom, examines the texture, shakes it, and hears it rattle, he pushes it and watches its movement, made erratic by its particular shape. These restatements of a basic concept by different methods and from different points of view are like the restatements of a melody by various instruments in an orchestra, first singly and then in concert, and give added meaning.

THE "FOURTH" DIMENSION

As a design problem, the communication of scientific information has no uniqueness other than its content. The same principles of communica-

tion govern it that apply to that of any other kinds of information. One of these principles is that, given a dynamic treatment, content will have different meanings or shades of meaning for different groups or individuals. This is full of possibilities. If one compares a situational illustration for a story in a slick magazine with a serious work of art by a painter, one is aware of an esthetic difference, and on analysis may discover wherein the difference lies. It is this: The painting has a continuing stimulus, whereas interest in the illustration is a quick spark quickly extinguished. What causes this difference? It is not necessarily the technical proficiencies of one work over the other. Many illustrators today are superbly equipped on a technical level. As a matter of fact, the styles of many great artists may seem comparatively crude and obscure. No, it is something quite different: The painting has universality, while the illustration is rigidly limited and completely defined and allows for no variance in interpretation. An artist knows that his own creativity is amplified and complemented as it stimulates a corresponding creative act in the spectator. The success of communication by the painting is this stimulation of the viewer to draw on his own personal background and experiences in order to elaborate, translate, and enrich, for him, the statement of the artist. Thus evolves a multiplicity of differences of reception.

These two acts of creativity—the production of the painting by the artist and the viewing by the spectator—are complementary and join to form an exciting and continuing communication. This I like to think of as the "fourth" dimension. It is partially this process that helps to establish the levels of communication in which we are immediately interested.

How does one define these levels of communication? At what level does one pitch an exhibit for the layman and at what level for the professional? The lay recipient requires more than a simple expression of scientific fact. His experience often does not include points of reference. It is the development of these points of references as links that challenges the ingenuity of the designer and gives stimulus and excitement to the message. In the field of exhibition, science should be related to life in the terms of the viewer of the exhibit. Man is still the most interesting single thing in the universe to man, and most measurements are made with ourselves as yardsticks. Communication using human symbols and human experiences as illustrations is most intensely engrossing. Scientists also are human and respond as the lay audience does to the use of these symbols.

I wonder if the key to a vivid presentation of scientific knowledge is *not* to work on the assumption that professionals and lay audiences are sheep and goats, but to incorporate in even professional presentation enough of the type of orientation that would interest an intelligent lay

group also. This would help to relate today's scientific profundities to life, even for the professionals, and dispel the eerie strangeness and sense of danger that such exposure holds for the non-scientist. A case in point was the International Science Pavilion at the Brussels Fair. As an exhibit planned primarily for professional scientists, it had few reference points for the casual layman and tended to bolster the prevailing picture of the scientist as a strange man, different from the rest of us. The limitation placed on much technical scientific communication by our not taking such a feeling of difference and strangeness into consideration is something to be pondered.

Two projects in which the author has been engaged recently may serve as interesting examples: One was multi-reproduced and sent to many viewers simultaneously over the world. The other was a large structural organism of interrelated techniques and statements to which viewers came from many countries.

Our first project was called "Planet Earth" and was a high school, visual-education project on geophysics prepared for the National Academy of Sciences. Although initially considered as a possible conventional traveling exhibit program, on analysis it became apparent that wide national and possibly international coverage should be accomplished by inexpensive reproduction of our material on a large scale (25,000 sets). Our written proposal stated in part:

These are the groups we must consider:

a. Students already actively interested in science as a career.
b. Students who, given the proper stimulus, might become interested.
c. Students oriented towards the humanities, who may feel that there is an antipathy between the humanities and the sciences.
d. Students without any definite pull in either direction, who might nevertheless be awakened by an approach that is aware of the sciences and the humanities as a single entity.

The approach included all four groups of students, with no attempt to establish any arbitrary "level" of either age or capacity. Most adolescents are far ahead of the books and other projects supposedly designed for them and are suspicious of any hint of being talked down to. No general concept is too difficult for a human mind of any age, if it is rendered in terms of his specific experience; children can often comprehend abstractions of a high order better than many adults who have been trained to reject such absolute concepts.

Our approach was one in which we translated these scientific concepts into terms of everyday experience wherever possible, on the assumption that we were addressing an adult of reasonable intelligence with little scientific background. Such an assumption substantially by-passed the danger of talking down and at the same time made the material thoroughly accessible, for example, to science teachers at first sight, obviating the

need for additional elaborate research.

We approached this audience as follows:

1. Questions: "Science wants to know . . . . . "
2. Terms: "What this means is . . . . . "
3. History: "This question first arose when . . . ."
4. Freedom of inquiry: "Our present idea of the answer to this question may be wrong."
5. Realms:
   a. The earth's core and crust
   b. The seas
   c. The lower and upper atmosphere
   d. The ionosphere, space, and the sun
6. Relationships: "This question also involves knowledge about . . . . ."
7. Disciplines: "The scientific tools we can apply to this question are . . . . ."
8. Unities: "All our past experiences with questions like this show that . . . . ." and "The answer to this question will also help to solve . . ."

To quote further from the proposal: "This approach will help students to connect the phenomena, the fields of inquiry, the disciplines, the tools, the skills, and the participants, and to develop an appreciation of knowledge for its own sake, as an illumination of all forms of human endeavor. Using the International Geophysical Year as a source of problems allows us to handle this vast philosophical point in dramatic terms, with the earth and the sun as protagonists, their relationships as mysteries to be solved, and individual sciences as sources of settings, characters, and action."

The ensemble for each school consisted of the following:

1. A set of six posters each three feet by four feet. I quote again from our proposal: "The panels will be conceived as a synthesis of all available graphic techniques: drawings and paintings, diagrams, charts, and photographs. Wherever appropriate, we will draw upon the great masters of art and literature. Each panel will be self-contained as to subject matter and capable of independent display, but related also to the others when they are displayed in groups of two to six."

2. A teacher's kit containing directives and suggestions on how to use the posters, as well as books of related experiments, bibliography, and the background on the disciplines discussed.

3. A set-up instruction folder detailing various methods of exhibiting the posters throughout the school or classrooms.

4. A set of thirty students' brochures reproducing the posters in full color and giving detailed explanations of the disciplines illustrated on the posters.

It is important to note that a primary factor in the planning and execution of such a program is the development of a plan for distribution. This includes the obtaining of adequate lists of possible users such as schools and libraries and a positive promotional effort to acquaint the

schools with the existence and availability of the new program. As much thought and effort must go into this type of communication as into the communication of scientific information incorporated in the program. Twenty-five thousand sets of visual aid material might easily remain snug in a warehouse indefinitely without such an effort.

The posters were planned to function on several levels: (a) as sources of specific information, (b) as stimulators of discussion on practically any topic, and (c) as classroom decoration. An enterprising and imaginative teacher could start a discussion based on any reaction by the students; whether it be to the style of artistic treatment, the symbols used, the quotations, or the specific scientific information. All other material was supportive in that it helped the teacher to initiate such a discussion.

Our second project was an exhibit on "Antibiotics—Molecules from Microörganisms" for the International Science Pavilion at the Brussels Fair, prepared for the National Science Foundation with a consulting committee of representatives of this country's leading antibiotics producers. Here the prime problem was the telling of a complex story on a floor space far too small for our requirements. This problem was resolved by our devising a two-story exhibit hall, which was constructed on location by a German crew, to house a series of related exhibits (constructed in the United States and shipped to Belgium and installed). With the second story cantilevered out on two sides, this provided a great deal more floor space upstairs than downstairs. A ramp provided access up from the first-floor level, and stairs brought the spectator down again. A planned traffic flow unfolded consecutive stages of the story material. Only parts of the area were visible from any one vantage point; new and surprising vistas and concepts were unfolded to the spectator as he moved through the exhibit. Although the exhibit was planned primarily for professional scientists, great care was taken to relate concepts and symbols to human aspirations and activities, which enabled a lay audience to understand and appreciate the broad statements implicit in the exhibit and made, we believe, for greater interest to the scientist. An interesting problem was presented by the fact that all copy was in three languages. This stimulated efforts towards the greatest possible graphic clarity as well as the tersest possible copy. The translation of scientific writing into different languages was discovered to be a trap for the unwary, with no adequate central agency available for clearance.

The completion of such a project as the one just described, which allows for no pre-testing, often leaves the designer full of ideas for revisions and improvements. Lucky is the one who has the budget and the sympathetic, patient co-operation of his "client" to enable him to improve his exhibits after they are installed and have been tested.

PICTURE CREDITS
Pages 9, 10, 13, 14, Naval Medical Research Institute, National Naval Medical Center; page 31, figure 1, Lothar P. Witteborg; pages 44–49, 51, 52, 54, 55, 57, 58, 60, 62, 63, New York State Historical Association; pages 78, 80–82, 85, Milwaukee Public Museum; all others, The American Museum of Natural History.